United States Centennial Commission.

INTERNATIONAL EXHIBITION,

1876.

REPORTS AND AWARDS

GROUP XXI.

EDITED BY

FRANCIS A. WALKER,

CHIEF OF THE BUREAU OF AWARDS.

PHILADELPHIA:
J. B. LIPPINCOTT & CO.
1877.

SYSTEM OF AWARDS

[*Extract from Circular of April* 8, 1876.]

Awards shall be based upon written reports attested by the signatures of their authors.

The Judges will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the Commission of each country and in conformity with the distribution and allotment to each, which will be hereafter announced. The Judges from the United States will be appointed by the Centennial Commission.

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Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Each report will be delivered to the Centennial Commission as soon as completed, for final award and publication.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress, and will consist of a diploma with a uniform Bronze Medal, and a special report of the Judges on the subject of the Award.

Each exhibitor will have the right to produce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

ORGANIZATION AND DUTIES OF THE JUDGES.

[*Extract from Circular of May* 1, 1876.]

Two hundred and fifty Judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the Groups to which they have been respect ively assigned. The foreign members of this body have been appointed

by the Commission of each country, in conformity with the distribution and allotment to each, adopted by the United States Centennial Commission. The Judges from the United States have been appointed by the Centennial Commission.

To facilitate the examination by the Judges of the articles exhibited, they have been classified in Groups. To each of these Groups a competent number of Judges (Foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the Departments of Agriculture and Horticulture, which will form temporary exhibitions, have been arranged in special Groups, and Judges will be assigned to them hereafter.

The Judges will meet for organization on May 24, at 12 M., at the Judges' Pavilion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

The Judges assigned to each Group will choose from among themselves a Chairman and a Secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a Judge in each Group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed, by a majority of the Judges in such Group.

The reports of the Judges recommending awards based on the standards of merit referred to in the foregoing System of Awards, must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the Judges on the subject of the Award, together with a Diploma and a uniform Bronze Medal.

Upon matters not submitted for competitive trial, and upon such others as may be named by the Commission, the Judges will prepare reports showing the progress made during the past hundred years.

Vacancies in the corps of Judges will be filled by the authority which made the original appointment.

No exhibitor can be a Judge in the Group in which he exhibits.

An exhibitor, who is not the manufacturer or producer of the article exhibited, shall not be entitled to an award.

The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the Judges. Upon request, he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the Commission relating to awards, subject to an appeal to the Commission.

A. T. GOSHORN,
Director-General.

[*Extract from Director-General's Address to Judges, May* 24, 1876.]

"The method of initiating awards which we have adopted differs in some respects from that pursued in previous exhibitions. In place of the anonymous verdict of a jury, we have substituted the written opinion of a Judge. On this basis awards will carry the weight and guarantees due to individual personal character, ability, and attainments, and to this extent their reliability and value will be increased. It is not expected that you will shower awards indiscriminately upon the products in this vast collection. You may possibly find a large proportion in no way raised above the dead level, nor deserving of particular notice. The standard above which particular merit worthy of distinction begins is for you to determine. In this regard I have only to express the desire of the Centennial Commission, that you should do this with absolute freedom, and when you meet with a product which you consider worthy of an award, we desire you to say, in as few words as you may deem suitable, why you think so.

"This, gentlemen, is all we ask of you in the Departments of Awards. Opinions thus expressed will indicate the inherent and comparative merits, qualities, and adaptations of the products,—information which the public most desires.

"Elaborate general reports and voluminous essays, though of great value as sources of general information, give little aid in determining the reliable or intrinsic merits of particular, individual products.

"The regulations which have been published divide the work of awards into three parts:

"1st. The individual work of the Judges.

"2d. The collective work of the groups of Judges.

"3d. The final decisions of the United States Centennial Commission in conformity with the acts of Congress.

"Each award will thus pass three ordeals, which, doubtless, will be ample and satisfactory."

GROUP XXI.

JUDGES.

AMERICAN.

George H. Bleloch, Springfield, Mass.

W. F. Durfee, New York, N. Y.

John A. Anderson, Manhattan, Kansas.

FOREIGN.

John Anderson, Great Britain.

François Perrier, France.

C. A. Angstrom, Sweden.

Auguste Gobert, fils, Belgium.

Felix Reifer, Austria.

GROUP XXI.

MACHINE TOOLS,—WOOD, METAL, AND STONE.

CLASS 510.—Planing, sawing, veneering, grooving, mortising, tongueing, cutting, moulding, stamping, carving, and cask-making machines, etc.; cork-cutting machines.

CLASS 511.—Direct-acting steam sawing machines, with gang saws.

CLASS 514.—Steam, trip, and other hammers, with specimens of work, anvils, forges.

CLASS 515.—Planing, drilling, slotting, turning, shaping, punching, stamping, and cutting machines. Wheel cutting and dividing machines.
Emery wheels and mountings.
Drills, taps, gauges, dies, etc.

CLASS 516.—Stone-sawing and planing machines; machines for dressing, shaping, and polishing; sand blasts; Tilghman's machines; glass-grinding machines, etc.
Circular saws.
Planing-machine knives.

GENERAL REPORT

OF THE

JUDGES OF GROUP XXI.

INTERNATIONAL EXHIBITION.
Philadelphia, 1876.

PROF. F. A. WALKER, *Chief of Bureau of Awards:*

SIR,—In compliance with the instructions contained in your letter of June 22, with reference to a general report on the machine-tools of the Centennial Exhibition, we have the honor herewith to forward our reports on the several exhibits of Group XXI. with our recommendations for award; and with that we also beg leave to submit our general report on the machinery of one of the most valuable and important sections in the Centennial Exhibition. We, the Judges, have the honor to be, sir,

Your most obedient servants,

JOHN ANDERSON, *Chairman*,
GEO. H. BLELOCH,
C. A. ANGSTROM
W. F. DURFEE,
F. REIFER,
JNO. A. ANDERSON,
F. PERRIER,
AUG. GOBERT, FILS, *Secretary*.

GROUP XXI.

MACHINE-TOOLS FOR METAL, WOOD, AND STONE.

The International Exhibition held on the grounds at Fairmount in 1876 will stand out prominently as the greatest ever held for the display of the various descriptions of articles that may be classed under the word useful, and still more was it remarkable for the unequaled collection of products that may be said to combine the useful with the beautiful. In no former exhibition of the products of industry had the pre-eminently useful class of machines which fall under the nomenclature of machine-tools, and of which Group XXI. takes cognizance, been so grandly represented; and the grandeur of that display is not effected by the mere repetition of well-known machine constructions, but rather by all that constitutes novelty, originality, and progress in regard to the rapid production of the goods and the reduction of cost, all tending in the direction of lessening the labor of the human race in the supply of its own wants.

The enormous stride which has been made in machine-tools since the ever-memorable Exhibition held in London in 1851 is a perfect marvel. The change, however, has gone on by a series of such imperceptible increments, that it is only the observing and experienced student who can appreciate the full measure of the advance that has been made. More especially is this the case in regard to the several classes of machine-tools for wood for which the United States have become so distinguished. In that year (1851) the comparatively small display of machinery for wood-working that was sent from America, and which was exhibited in London, took the rest of the world by surprise; but even that display, if now placed beside the gigantic and unrivaled collection that was here displayed at the Centennial, would be considered as scarcely worthy of award or even of notice. Still, it contained the living germ, which has, under the fostering ingenuity of many inventive minds, grown up to the colossal dimensions of 1876; and to enable the general public to know the

vast advance that has been made it would require the two to be placed side by side.

In regard to circular saw-mills for cutting up the round logs of the lumber-trade, the United States made a very grand and unequaled display. This class of machinery has been the subject of much study, and has at length arrived at a very high standard of excellence. It is distinguished for efficiency and rapidity of execution, and is worthy of the study of all energetic nations.

Since 1873 the progress made in wood-working machinery is most conspicuous. Ever since 1851 the old flimsy forms have been gradually giving way to a more substantial manner of construction, and the tawdry finery of paint in various colors has given place to a more severe and uniform style. At Vienna most of the American exhibits appeared in a greatly improved character; and at the Centennial Exhibition we had nearly all the larger class of firms with entirely new designs of the highest excellence, and with such originality shown in every direction and pervading all classes of machine-tools, and to such an extent, as to warrant us in saying that never before had so much originality been brought together in one place as at Fairmount Park in 1876. In America alone there were upwards of eighty large exhibitors of wood-working machinery, many of the single firms showing an immense number of different classes of machinery, most of them characterized by great refinement, accuracy, fitness for their intended purpose, balanced spindles, and minute attention given to truth in the details. So marked was the change, that in wood-working machinery the United States may be considered as taking a new departure from the Centennial year.

Similar remarks apply to the metal-working tools of America, but their points of excellence are of a still higher order of refinement and mathematical precision, and they stand out in every respect that contributes to perfection in work, both as regards mathematical accuracy and the reduction of cost in the product.

Notwithstanding the fact that a number of different countries contributed their good-will offerings to the Centennial, it must yet be distinctly understood that, so far as machine-tools are concerned, the enormous display from the United States so far exceeded that from all the rest of the world put together that, in this section, the competition may be said to have been American rather than International.

RUSSIA.

The machine-tools displayed by Russia were limited in number. Still, Russia made a better display at Philadelphia than she did at London, Paris, or Vienna; more especially in the beautiful collections of the polytechnic schools of Moscow and St. Petersburg, both showing remarkable progress in refinement and precision in all the elements of applied mechanics, a branch of the utmost importance to that country, where such knowledge is not inbred in the population, as is the case in some other countries. A private firm from Russia also displayed some fine specimens of machine-tools for metal, of excellent construction.

BRAZIL.

The Empire of Brazil presented some well-constructed tools, or machines, in connection with mint operations. These specimens of good workmanship were excellent in their style and finish.

SWEDEN.

The machine-tools sent from Sweden were worthy of all commendation; everything sent was good of its class, and all were notably free from prevalent mechanical errors. At each recurring Exhibition this country invariably shows progress, and on the present occasion its sawing-machinery and that for cartridge manufacture were deserving of careful examination.

BELGIUM.

Belgium did not show much in this section, but everything exhibited by that kingdom was very good. A machine for making nuts, more especially, was very superior; and although, from some arbitrary reason, it was not classed with machine-tools, yet we venture to say that it shows a remarkable degree of progress since the Exhibition of Vienna, 1873.

FRANCE.

Considering the distance from Philadelphia, France did well at the Centennial Exhibition. In wood-machinery more especially she greatly excelled. France alone had the credit of planing with the helical-cutter; at Vienna it was the object of much admiration, and was here again submitted, and is deserving of commendation. An ingenious method of shaping the staves of casks was characterized

by much refinement, affording mathematical accuracy combined with rapidity of execution, and is well worthy of study by the tool-makers of other nations.

GERMANY.

Although Germany showed little in the section of machine-tools, still, it presented one machine of great merit. It was for cutting the teeth of small bevel-wheels by a circular cutter, to which was added a second motion that gave a sort of wabbling movement to the cutter, thereby shaping out the required mathematical lines, or was capable of being made to do so. This was one of the gems of the Exhibition; although in its construction at the present time it is a rough diamond, still, it contains the germ of a useful machine. Another tool for grinding flat surfaces is ingenious in some of its arrangements, but is not quite so perfect in its details.

CANADA.

Canada made a great and noble effort. Some of its machine-tools had considerable merit and contained many points of originality. They were all of good, sound workmanship, and, taken altogether, were good, serviceable tools, and showed encouraging progress. It may be remarked, however, that the true tool spirit is not yet so fully developed as it undoubtedly will be. At the present time, whenever Canada holds on to established lines of construction, it does well; but when it ventures to leave the beaten track, it is apt to stumble and to introduce devices that are ingenious but imperfect in principle. Its beautiful radial drill is marred by an apparently trifling detail, yet this trifle reduces the value of the machine, at least where accuracy and precision are essential. As a whole, Canada showed much progress at Philadelphia.

GREAT BRITAIN.

With the exception of the United States of America, Great Britain made the largest display of machinery at the Centennial Exhibition. In machine-tools, however, that country was scarcely represented. A remarkable exception was the steam-hammer sent from Manchester. The birthplace of the steam-hammer contributed a grand display, which was worthy of the most careful examination by earnest students who desire to learn a lesson in good, sound construction. Another ingenious machine, from Lancashire, was for engraving calico-printing rollers, or rather for stamping by impact, or by milling, or by both combined. Leeds put forward several good machine-tools for various

purposes; but when all are reckoned up they were as nil when compared with one exhibit from Philadelphia which stood alongside, and which threw all other, and, indeed, all former exhibits by single firms, entirely into the shade. England likewise supplied an excellent and most valuable machine for dressing stones, which was well worthy of careful attention. We regret that Great Britain, which stands so high in this class of machinery, was not better represented. The exhibit of that country was conspicuous by the absence of all the well-known names with which the world has been familiar.

REPORTS ON AWARDS.

GROUP XXI.

1. Pratt & Whitney Co., Hartford, Conn., U. S.

MACHINE TOOLS FOR WORKING METALS.

Report.—This company exhibits forty-nine (49) machine tools for working metals. These tools are to be commended for the admirable character of their general design, which shows the result of careful study and large experience applied to the determination of the proportion and union of parts in the several tools, with the view of eliminating unnecessary details, thus at once cheapening their construction and improving their qualities as working machines. In fact, the simple method adopted for attaining the desired ends is one of the conspicuous merits of this magnificent collection of machine tools.

This feature of simplicity is exemplified to a greater or less degree in all the tools and machines composing this exhibit, but it is especially manifested in the very ingenious and thoroughly efficient device for conical or taper turning, which can be attached to all of their lathes, as well as in the general design and working details of the lathes themselves; in the ingenious mechanism for shifting the belts on the planer exhibited, as also in the novel means devised for changing the traverse of the planer-bed without loosening the stops on its side, which enables the work in hand to be run out from under the tool for such a distance as suffices for a convenient examination, after which the work can be resumed with precisely the same traverse of bed as before.

The upright drill has a very simple and effective power "feed," and also an ingenious method of determining the depth of the hole as the work progresses. The gang or multiple spindle drills exhibited are simple in design, of excellent workmanship, and convenient in manipulation.

Included in this exhibit are a number of tools designed for use in the manufacture of fire-arms, sewing-machines, and other small varieties of mechanism. These are well thought out, and are constructed in a faithful and workmanlike manner. They contain very many ingenious methods of adjustment tending to facilitate the execution of work and to preserve the original accuracy of the tool itself. Among these may be mentioned a peculiarly simple and efficient vise, which can be used either on the planer or shaping machine for holding work,—a very satisfactory method of securing the tool holder of the shaping machines at any desired angle,—and an index scale for facilitating the adjustment of the proper length of stroke of the slide bar. This index scale is situated on one side of the slotted lever by means of which the slide bar is moved.

They exhibit a large variety of milling machines which are characterized by simplicity and originality of design coupled with excellent workmanship. Among the smaller of the machines they exhibit is a very simple and original mechanism for grinding the cutters of milling machines, which is adapted to grinding either cylindrical or conical cutters.

The various bolt-cutters shown are well-built and efficient machines, and contain some

original details which tend to increase the convenience of manipulation of the tool. In the machines exhibited for making screws for small machinery, we find several novel and ingenious devices which materially increase the productive capacity of the tools and at the same time render them less liable to accident in use.

The horizontal boring milling shown is a heavy and substantial tool, which possesses several points of decided originality, all tending to augment the convenience and working capacity of the machine. They also exhibit a very powerful and strongly-built press for striking medals or raised ornamental work, which is simple in construction and effective in action. It is shown at work, striking the Exhibition medal.

Their power shear for cutting round and flat bar-iron is designed with great propriety, and contains many details of a very original and satisfactory character, among which may be named the adjustable guard for holding the iron while being cut.

The smaller power press has a very novel method of adjusting the punch or upper die by means of a moving hydraulic cylinder, to the bottom of which the punch or die is attached. This detail, which is of marked originality, fulfills its intended function in a very satisfactory manner.

This company exhibit sets of taps and dies of both Whitworth and Franklin Institute standard, of admirable construction and finish; and their series of "cylinder" and "plug" gauges is distinguished by the beautiful milled surfaces by means of which they are handled, as well as by the extreme accuracy indispensable to such standards.

Among the special tools for the manufacture of fire-arms the rifling machine stands conspicuous for its general elegance and originality of design, and the perfection with which its several details perform their assigned functions.

The profiling machine shown contains a very original and satisfactory method of cutting "formers" without reversing the fixtures, and all the gearing for moving the "table" and "cross slide" is double and made adjustable in order to remove "back-lash," a matter which is important in order to secure the desired perfection in the product of the machine.

Among the most original and well-studied tools of this firm must be classed the "horizontal revolving head drilling or chucking machines," which contain a multitude of most original and ingenious ideas, which are carried into effect in a manner which admirably illustrates the perfection attainable by supplementing the prolonged study of the designer by the careful and conscientious skill of the trained workman.

One of the most interesting and original of the machines exhibited is intended for varnishing the interior of the powder-chamber of metallic cartridges. This is the first machine that has ever accomplished this work and substituted the unerring precision of machinery for the uncertainty and irregularity which to a greater or less degree always attends the mere routine labor of the human hand in the case of work requiring rapidity of execution, and which, when complete, is inspected with difficulty. In this varnishing machine we have admirably illustrated in several instances, as an adjunct to its more important movements, what may be called a thinking and recuperative power, through the agency of which any temporary accidental imperfect action is corrected, or the machine is at once stopped altogether. In these various "stop motions," as they are called, the designer of this machine appears to have impressed upon it and immortalized a part of his own volition, for they stand amid the mechanism like sentinels of thought, ready to challenge with promptness and resist with success any attempt of imperfection to pass their several posts.

As a whole, and in detail, this machine is entitled to commendation for great originality and ingenuity of design, combined with admirable mechanical execution.

As the result of a prolonged and very careful series of tests, the mechanical accuracy of this exhibit was found to be of a high and very satisfactory character, and the exhibitors are entitled to great commendation for the zeal and enthusiasm manifested by them in submitting their machines to an examination which has resulted in establishing the remarkable perfection of their construction.

2. Putnam Machine Co., Fitchburg, Mass., U. S.

MACHINISTS' TOOLS.

Report.—Commended for a class of workmanship that has probably not been excelled; marvelous accuracy, amount and quality of materials used in the construction of the tools; elegance of design and harmony of proportions, affording the greatest strength for the amount of metal used; and for arrangement of parts, making them convenient and securing great economy in working; also for surface finish, which is one of the features of the machine-tool exhibition.

The marked features of the planing machine are the angular feed in the head, by which any angle may be planed; the arrangement for raising and lowering the cross-beam and head by power; and the yielding shipping arrangement, by which the belt is made to move more rapidly from one pulley to another with regard to speed or the amount of labor done by the machine.

The special features of the lathe deserving commendation are the simple and effective cross-feed; the eccentric nut on the feed-screw; the device for clamping tail spindle; the binder for securing the carriage when the cross-feed is in use; the reversing gears for right- and left-hand screw cutting; the friction overhead pulleys; and the generally remarkable accuracy.

The slotting machine has an ingenious relief motion, by which the work is moved from the point of the cutting tool, preventing wear and injury on the return stroke; this is done without any joint in the cutting tool or in the sliding bar; thus the full strength of the cutting is not impaired; also a friction-stop by which the machine can be stopped at any point of the stroke.

The bolt-cutting machine has an original arrangement of the head for holding the dies, so managed that the dies may be readily removed, and which admits of their being moved together as they wear, without hindering the operation of the machine; also for an oil-pumping device which gives three jets of oil to each revolution of the head.

The vertical car-wheel borer is marked by splendid proportions and powerful construction. It has a combination chuck with universal and independent jaws, and a double elliptical spindle, and a convenient hoisting crane; also a very convenient and effective feeding arrangement.

The drilling machine has a combination of lever, worm, and power feed, and a counter-balanced spindle which prevents the drill-spindle from dropping as the drill passes through the work. The table has a diameter of twenty-four inches, and is movable around the column, thus making its adjustment perfect at any desired point.

The axle-lathe has a solid spindle bearing, with novel method of tightening when it becomes worn, lock-feed nut and new shifting device, and great strength combined with power and convenience.

Collectively and in detail, the tools exhibited by this company show refinement in design; thorough and exhaustive calculation of the relative strength of the respective parts; a minute delicacy of accuracy which is the admiration of the most accomplished mechanics and engineers of the day; an ease, smoothness, and perfection of motion which will insure the reproduction of the finest work; and a general surface finish which has certainly never been surpassed and is not commonly known to have been equaled.

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3. Brown & Sharp Manufacturing Co., Providence, R. I., U. S.

MACHINE TOOLS FOR METAL.

Report.—This firm have an exhibit numbering twenty-six machine tools for working metals. These tools are mostly designed for use in the manufacture of the smaller class of mechanism, and are characterized by great neatness of design and excellence of execution. The universal milling machine of this firm is especially noteworthy for the excellence of

its workmanship and its adaptation to every variety of work that such a tool is ever called upon to perform; and their universal grinder is an exceedingly substantial and well-studied machine, whose working details are especially well managed for facilitating the work it is called upon to perform.

They also exhibit a number of index plates for wheel-cutting machines which are very creditable specimens of their ability to turn out work of that kind.

Among the smaller tools in their exhibit must be named a large variety of milling machine cutters, which are so constructed as to admit of repeated sharpening without destroying the accuracy of the original cutting of their teeth. This is an important peculiarity and deserving of especial mention.

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4. Washburn Machine Shop, Worcester, Mass., U. S.

MACHINE TOOLS FOR METALS.

Report.—This shop is connected with the Worcester Free Institute of Worcester, Mass., and it presents as its exhibit seven machine tools for working metal. These tools are shown as the work of the students, and are very excellent specimens of design and workmanship, embracing many original ideas which are substantial improvements upon ordinary practice. The frames of the lathes shown exhibit a correct feeling for appropriate outlines and forms for such machines, and the workmanship is first-class. Great credit is due to Mr. Higgins, the superintendent of this shop, for the excellent character of this exhibit, which is the substantial evidence of the success of technical education in the institution from which it comes.

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5. R. S. Newbold & Son, Norristown, Pa., U. S.

ROTARY METAL SHEARING MACHINES.

Report.—This firm are exhibitors of two machines for cutting sheet metal by means of revolving circular cutters. One of these is designed for cutting along straight lines, and the other for cutting on the circumference of a circle.

These machines are deserving of commendation for the satisfactory character of the design and the excellence of their mechanical execution.

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6. American Saw Co., Trenton, N. J., U. S.

PUNCHING, SHEARING, AND PRESSING MACHINES.

Report.—This company exhibit several machines for punching, shearing, and pressing metal, which contain several points of marked originality and ingenuity.

These machines are well designed, and perform their allotted work in a very satisfactory manner.

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7. Brainard Milling Machine Co., Boston, Mass., U. S.

MILLING AND OTHER METAL-WORKING MACHINES.

Report.—This company exhibit nine machine tools for working metal. The more conspicuous are milling machines of various sizes and kinds. These tools are of good design, and are built in a thorough and workmanlike manner. They deserve especial commendation for their universal milling machine, which is adapted to every variety of work that can be done in such machines.

The results of rigid tests show that the workmanship was exceedingly accurate in all of these machines. They also show samples of steel jawed cast-iron bench vises of their manufacture, which contain several features of marked originality, tending to augment the durability as well as the utility of this tool. Commended for general originality and ingenuity of design combined with admirable workmanship.

8. J. H. Sternbergh, Reading, Pa., U. S.

SURFACE-GRINDING MACHINE.

Report.—Commended for excellence of construction and special adaptation in a machine for producing flat surfaces in grinding with the emery wheel; also for the application of a fan whereby the metallic dust is conveyed to a distance for deposit.

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9. Northampton Emery Wheel Co., Leeds, Mass., U. S.

MACHINES FOR GRINDING WITH EMERY.

Report.—Commended for excellence of design in the construction of machines variously adapted to different purposes in connection with grinding by emery wheels, as also for good sound workmanship in connection therewith; likewise for originality shown in many ways, more especially for devices to secure absolute truth in the grinding of circular saws, and still more specially for an ingenious combination of grinder with an adjustable table, whereby the interior lines of articles may be ground either horizontally or at any required angle; also for variously shaped emery wheels, whereby hollow lines may be ground on shearing blades or other cutting instruments.

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10. Union Stone Co., Boston, Mass., U. S.

EMERY WHEELS AND OTHER GRINDING MACHINES.

Report.—Commended for general excellence throughout; for the large dimensions and high qualities of their emery wheels; for a considerable trace of originality displayed in some of their grinding machines; also for refinement shown in some adaptations for sharpening tools or instruments, and for the high standard they maintain.

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11. American Twist Drill Co., Woonsocket, R. I., U. S.

MACHINES FOR GRINDING WITH EMERY WHEELS.

Report.—Commended for good construction of various descriptions of machines for grinding with emery wheels. Some of the tools are automatic, and are as well made for their purpose as can be desired. Also for a trace of originality in the construction of emery wheels, whereby a portion of the structure may be of iron and serve as a frame on which to form the exterior emery wheel.

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12. Hardy Machine Co., Biddeford, Me., U. S.

GRINDING MACHINERY.

Report.—Commended for good construction of various machines used in grinding different classes of articles, and notably for grinding or sharpening teeth of cylinders for carding machines. Shows a trace of originality. Its duplex screw reversing motion is well carried out.

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13. Oberlin Smith & Brother, Bridgeton, N. J., U. S.

MACHINES FOR WORKING TIN PLATE.

Report.—Commended for sound construction and ample bearing surfaces in a variety of machines for working tin plate. These machines are characterized throughout with much ingenuity in details, and they are severally well adapted for their special purposes.

14. Clough & Williamson, Newark, N. J., U. S.

MACHINE FOR MAKING CORK HANDLES OF WIRE.

Report.—These handles are a new article of manufacture, and the machine which produces them at the rate of thirty-two per minute is distinguished for great originality and ingenuity, and is to be commended for these features, as also for the cheapness and perfection of its product.

15. Jones, Lamson, & Co., Ascutney Mills, Windsor, Vt., U. S.

SCREW-CUTTING MACHINE.

Report.—Commended for originality displayed in the construction of improved screw-cutting machine.

16. H. Burden & Son, Troy, N. Y., U. S.

HORSESHOE MACHINE MODEL.

Report.—The above firm are the exhibitors of a model of their machine for making horseshoes. This model is shown at work making miniature horseshoes from rods of block-tin. The shoes are made with great perfection at the rate of sixty per minute, and it is believed to be the only machine that takes the iron from the rolling-mill and converts it into shoes creased ready for punching at one operation without re-heating.

This machine is entitled to high commendation for great originality of design and perfection of operation.

17. Branch, Crookes, & Co., St. Louis, Mo., U. S.

STONE-SAWING MACHINERY.

Report.—Commended for the construction of an admirable system of machinery for sawing stone, by means of circular saws of great diameter and speed, with the teeth of the saw formed of diamonds, the teeth being inserted in a most ingenious manner to insure efficiency and prevent deterioration. Considered as a whole, this is a very superior exhibit, showing progress, and is worthy of great commendation.

18. Emerson Stone-Saw Co., Pittsburg, Pa., U. S.

DIAMOND STONE-SAWING MACHINE.

Report.—Commended for sound construction shown in the arrangement of machinery for sawing stone by means of a circular disk of steel, seventy-two inches in diameter, provided with a series of diamonds on its periphery. The manner of holding the diamonds is ingenious, original, and efficient, and the mechanism as a whole is deserving of approval for its satisfactory practical operation.

19. Thos. Ross, Rutland, Vt., U. S.

STONE-SAWING MACHINE.

Report.—Commended for good arrangement in the design and construction of a machine for sawing stone. It is convenient, powerful, automatic, and contains some points of originality.

20. Steam Stone-Cutter Co., Rutland, Vt., U. S.

STEAM STONE CHANNELING OR QUARRYING MACHINES.

Report.—Commended as ingeniously designed, strongly made, entirely automatic in their action, and for marked originality of the ideas involved.

21. Hugh Young, New York, N. Y., U. S.

RECIPROCATING STONE-SAWING MACHINES.

Report.—Commended for ingenuity in design and for excellence of workmanship in the construction of stone-sawing machinery.

In this diamond saw machine the diamonds are made to act upon the stone in such a manner as to receive pressure or blow in one direction only, thus avoiding the alternate reverse action which displaces the diamonds.

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22. Stacy Stone-Dressing Machine Co., New York, N. Y., U. S.

STONE-DRESSING MACHINE.

Report.—Commended for an ingenious and original combination of machinery for dressing stone, in which the cutting implements have a peculiar recoil movement imparted to them, which gives a close approximation to the action of point tools.

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23. George C. Howard, Philadelphia, Pa., U. S.

GRINDSTONE HACKER.

Report.—Commended for the contrivance of an instrument, called a "hacker," that is used in trimming grindstones. This hacker turns with the stone, and is drawn across in a slide rest, and fulfills its important function satisfactorily.

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24. J. E. Mitchell, Philadelphia, Pa., U. S.

GRINDSTONE GEARINGS.

Report.—Commended for the highest excellence, as shown in a complete system of grindstones with their appendages and accompaniments.

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25. The Billings & Spencer Co., Hartford, Conn., U. S.

DROP FORGINGS.

Report.—This firm are the exhibitors of a very large collection of "drop forgings" which illustrate in a very thorough and effective manner the comprehensive character of the art of pressing or stamping hot metal in dies of various forms. The forgings shown of the jaws for a pipe vise are very complicated in outline, and could not have been produced by the ordinary method of hand forging.

They show a large variety of sewing-machine shuttles, wrenches, parts of fire-arms, handles, and thumb screws. As a magnificent collection of drop forgings, which illustrate in the most satisfactory manner the capacity of the art of forging in dies for producing the most complicated as well as the more simple forms of forged work, as well as for the excellence of the several samples of which it consists.

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26. H. Hammond & Co., Hartford, Conn., U. S.

DROP FORGINGS AND STEEL HAMMERS.

Report.—This firm are the exhibitors of drop forgings, and their exhibit embraces a number of specimens which are admirable examples of the art of producing forgings in dies; these specimens include intricate parts of muskets and pistols, as well as a variety of forms and sizes of hammers. All the samples shown are admirably executed, and the exhibitors are to be highly commended for the general excellence of their workmanship, and especially for that shown in the drop forgings of claw-hammers, whose very intricate and difficult form they have successfully produced by this method of forging.

27. John Roach & Son, New York, N. Y., and Chester, Pa., U. S.

WROUGHT IRON FORGINGS.

Report.—For magnificent forgings in wrought iron, consisting of a paddle-wheel shaft twenty-two inches in diameter and thirty-six feet long, weighing fifty-three thousand two hundred and twenty-five pounds, finished; wrought iron crank weighing nine thousand two hundred and fifty pounds; this crank is intended for an engine of fourteen feet stroke; also a single-throw crank shaft, finished complete, with couplings on each end.

The firm is entitled to great credit for its enterprise in erecting the plant and securing the skilled workmen necessary to the production of such splendid specimens of workmanship in forged iron.

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28. The Hull & Belden Co., Danbury, Conn., U. S.

FORGING HAMMERS AND DROP FORGINGS.

Report.—Commended for originality, simplicity, durability, economy in the use of power, for general excellence and superiority, and for the great range of work to which they are adapted.

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29. William Sellers & Co., Philadelphia, Pa., U. S.

STEAM HAMMERS AND MACHINE TOOLS.

Report.—A remarkable collection of machine tools for working metal. This exhibit, when considered in regard to its extent and value, its extraordinary variety and general excellence, as also for the large amount of originality that is shown in the numerous new devices that are introduced, is probably without a parallel in the past history of international exhibitions; and taken as a whole it is worthy of the highest honor that can be conferred. Besides, it is thoroughly national in its characteristics, and pre-eminently worthy of the United States and of the grand occasion of the Centennial Exhibition. Every single machine, tool, or piece of apparatus that is displayed in this vast offering would for itself command the strongest recommendation for an award, even if it stood alone as a unit. But here every unit is surrounded by thirty-three distinct machines, each one being of the highest standard in its particular class. The whole of these machines are characterized by extreme refinement in every detail, by the superior quality of material employed in their construction, by first-class workmanship, both in regard to nice fitting and precision, and for the mathematical accuracy of all the parts; by the beautiful outlines that are imparted to each structure; by the correct proportions that have been worked out in the determining of strength and form, and the disposal of material to take full share of duty.

For the scientific skill displayed in the application of mechanical force; for the daring shown in fearlessly breaking through the trammels of the past by introducing variously-constructed devices and arrangements of gearing for the transmission of power in more direct course to the point of action, yet maintaining correct construction mechanically and without departure from true principles.

As it is impossible to realize the full measure of such refined, mechanical, scientific, and artistic merit by the foregoing remarks, it is deemed necessary to enumerate briefly some of the more prominent points in the several machines, both in justice to the exhibitors and to the judges.

Steam Hammers.

Commended for general excellence of construction throughout, more especially for originality in the form and arrangement of the working hammer, and likewise the hammer head, and for the manner in which the head is secured to the hammer; and for the practical results which flow from the arrangements and the convenience of fixing and unfixing which the combination affords; for originality in the mode of working the steam valve, and for the introduction of several marked improvements in connection therewith, by which

the steam part of the apparatus is put under favorable conditions for efficiency, either for automatic working or by hand, and by which the blow is effectually controlled.

Machine for Grinding True Surface Plates.

Commended for originality, both in regard to the idea or principles of this machine, and also for the design and development into a practical tool for the engineer, whereby a surface which is mathematically a true plane can be transferred to other surfaces, even of the most obdurate materials, either hardened steel or chilled cast iron, the means employed being simple and inexpensive.

Machine for Grinding Drills.

Commended for originality in the idea and excellence of the design of an apparatus for grinding the edge of drills in such a manner as will insure mathematical accuracy, both in the angle and the cutting edges, at the minimum of cost; by which means the dull instrument is rendered more efficient; it performs more and better work than is practically obtainable by the usual system, even in the hands of a skilled workman.

Planing Machines.

Commended for originality, general excellence, and refined mechanical skill in the construction of planing machines for metal. New combinations of gearing, made up of various original devices, are introduced, whereby greater efficiency, strength, and economy are obtained, as well as a soft, uniform, easy motion to afford smooth planing.

For originality in the various arrangements connected with belt motions; for convenience of manipulation by the attendant; to avoid the usual struggle between the open and cross belts at the reversing points, thus economizing power and avoiding wear and tear. Also for originality in the means employed for giving the feed motion at the proper nick of time, as also for the arrangement which raises the cutting instrument from the work during the return of the planing table, which is both direct and decisive; and as a whole the belt and feed combination is characterized by great mechanical refinement, the result of matured thought and experience.

Self-Acting and Screw-Cutting Lathes.

Commended for general excellence and extreme mechanical refinement in all the details that determine accuracy of production in regard to true circles, true cylinders, and true planes; for originality in the method adopted for fixing the shifting head, the introduction of an under V within the bed, whereby the head is always drawn up to the same straight line in the mathematical sense, and thus avoiding the necessity of a tight fit and its attendant disadvantages; for the adoption of a method which insures the retention of truth in spindles and more especially in their relation to their centres; for originality both in the conception and design of an admirable system of feed motion, consisting of a simple combination of disks, whereby the feed rate may be altered from one extreme to another, or to any intermediate point, by a momentary touch of the attendant, thus affording the skillful and zealous workman an opportunity of developing the produce of the lathe to its utmost capacity, and, along with that, the reduction of cost.

Chasing Lathe for Brass Work.

Commended for originality and general excellence in its design and construction, and for a simple combination of mechanical devices to serve a special purpose, whereby the turning, boring, and screwing of brass work generally may be executed with great accuracy, as well as more rapidly and economically than can be done in an ordinary lathe; as in it the functions are general, but here they are more special in their adaptation to a class, and consequently more convenient.

Wheel-Turning Lathe.

Commended for its great stability and general excellence of construction as a machine tool, and for the convenient adaptation of various devices to a special purpose of great importance, namely, for turning the driving-wheels of a locomotive correctly and at the minimum of time and cost, with such arrangements as will enable both wheels to be acted upon at the same time. The beautiful outlines and the grandeur of this tool are worthy of the highest commendation.

Boring and Turning Mill.

Commended for its sterling qualities as a machine tool, more especially with reference to its utility and accuracy. It is also distinguished for the manner in which the material is disposed, as well as in regard to the forms and general proportions of the parts, and its adaptation to the intended special purpose, to obtain mechanical truth and accuracy at a moderate cost.

Car-Wheel Boring Mill.

Commended for the general excellence of design and construction, and the admirable adaptation to a special purpose, which has to be repeated an indefinite number of times in order to perform the operation accurately and economically. To meet these conditions, various adjustments are provided by means of which the car wheels are conveniently put on to the machine, then bored and faced, and removed from the machine in shorter time than would be required in the ordinary boring and turning lathe.

Cylinder Boring and Facing Lathe.

Commended for the remarkable excellence of the general design, and for the sterling qualities that pervade the details throughout. This grand tool is an embodiment of all the tool virtues that can be enumerated, resulting in the transmission of mathematical truth and accuracy to the work performed, combined with great rapidity of execution and consequent economy; thus realizing the highest ideal conditions. Still more, this machine is constructed in such a manner as will enable it to maintain its inherent faculties unimpaired for a long time.

Automatic Gear-Cutting and Dividing Machine.

Commended for the great mechanical perfection in its various functions, to perform operations both difficult and recondite, and which for the particular purpose is without a compeer. The designer of this machine has so embodied his own mental faculties into its material combinations that they are involuntarily constrained to do his will when power is applied, and without any human assistance. All this it performs with the utmost accuracy and at the minimum of cost.

Slotting Machine.

Commended for originality of construction, especially in the part in which the slotting-bar slides, whereby stiffness is imparted and a steady cutting action; and for the manner in which the machine is fitted with best known arrangements for giving the proper rate of motion to the cutting instrument with a quick return; also for the refined and convenient arrangement whereby the feed is given at the exact and proper nick of time in relation to the stroke.

Shaping Machine.

Commended for general excellence as a shaping or planing tool, with the most approved devices for actuating the cutting and return motions; and for the perfect arrangement to secure truth and parallelism in the work performed, and in order that the parts may retain their faculties during a long period of hard work, which is a high virtue in a tool of this class.

Horizontal Drilling and Boring Machine.

Commended for originality and general excellence in design, especially in regard to the introduction of the "disk-feed motion," whereby the production of the machine may be increased; also for the addition of what is called a "coarse feed," by which finishing cuts may be performed more rapidly and with equal efficiency; also for the very convenient arrangement of the manipulation handles, and for avoiding all embarrassment to the workman in the performance of various operations to which the machine may be applied.

Wheel-Quartering Machine.

Commended for, first, conception of the idea, and, second, for devising the way in which the idea was to be carried out; and for the extreme care and accuracy that have been bestowed upon its construction to insure absolute truth in the division. Considered for its manifest utility and perfect adaptation to perform a most difficult operation, this tool is a most valuable addition to the engineering workshop.

Double-Geared Vertical Drill.

Commended for the general excellence of the design and for certain original modifications by which the efficiency of the machine is improved both in regard to quality and quantity of produce.

Bolt and Nut Screwing Machine.

Commended for general excellence of design, and for many distinct points of originality, all pointing to increased efficiency as regards accuracy, rate of production, durability, and convenience; likewise for new devices to secure more perfect flooding of the work with oil during the cutting, and for the economizing of the oil so treated. This is probably the most perfect machine which has been constructed for this purpose, and deserves the highest commendation.

Combined Punching and Shearing Machine.

Commended for general excellence of design; for the proportions of strength at particular points to meet successive strains; and for the soundness of the entire structure; also for the convenient manner in which the punching die is arranged in order to give facility for operating upon varied and intricate forms of articles; as also for the very perfect "stop motions" that are applied both to the punching and shearing slides.

Plate-Shearing Machine.

Commended for great originality in its arrangement, the excellence of its general design, and the admirable manner in which various ideas have been combined and reduced into a harmonious, sound, and convenient practical tool; also for convenient arrangement to afford handy manipulation, precision in cutting to any determined point upon a line, the determining motions being automatic; and for skillful distribution of the shearing strains and their entire expenditure within the structure.

Angle-Shearing Machine.

Commended for originality, and for the sound and scientific principles which have been displayed in its arrangement and construction; for the avoidance of certain mechanical errors that are too common, whereby inordinate friction is developed at certain vital points of action. In this machine these pressures are distributed by simple means, thus affording greater permanence of wearing parts, economy of power, increase of capacity, and other advantages. Such combinations are the result of close thinking by men who are engineers "to the manner born."

Nut-Shaping Machine (System Bathó).

Commended for originality and great efficiency, and for its construction upon an entirely new idea and principle of arrangement. In connection with this machine, commendation

to distinct parties is due. First, to the inventor, for the original design and its special fitness for a purpose; for its general utility to supply an extensive want; and for the economic production which it affords. Second, to its makers, Messrs. Wm. Sellers & Co. (the exhibitors), for three distinct points of originality which they have introduced into the machine, and for superiority in its construction.

Hydraulic Riveting Machine (System Tweddell).

Commended for originality of high order. In connection with this machine, commendation to distinct parties is due. First, to the inventor, for the original ideas that are embodied; for the original design, and for the combination of well-known mechanical or hydraulic devices or apparatus whereby an important advance has been made in the execution of great works of construction; for simplicity of means, affording a controlled pressure, promptitude, and certainty of action, and which is accomplished in silence.

Secondly, to the makers and exhibitors, Wm. Sellers & Co., for their superiority of construction, and for the introduction of certain original devices by means of which the efficiency of the machine is improved, the power required to work it reduced, the accumulation simplified, and the weights are more conveniently arranged for being shifted for the determination of pressure; and likewise for the admirable manner in which the best materials and workmanship have been combined in order to insure success in the development of this new and most valuable apparatus before the engineers of America.

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30. Chas. Merrill & Sons, New York, N. Y., U. S.

DROP HAMMER.

Report.—Commended for superior design and construction of a drop hammer, and for originality in some of the arrangements, whereby a most efficient tool is obtained, and which, from the area of the surfaces, great permanence of condition is secured; also for a well-constructed machine for trimming the "fins" from forgings. Both tools are first-class for their intended purpose.

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31. Stiles & Parker Press Co., Middletown, Conn., U. S.

STAMPS, DIES, AND POWER HAMMER.

Report.—Commended for excellence in construction of machine tools, more especially for ingenuity in the manner of adjustment of stamps and dies, and for the arrangement of power hammers.

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32. Bradley Manufacturing Co., Syracuse, N. Y., U. S.

RUBBER-CUSHIONED HELVE HAMMERS.

Report.—Commended for first-class cushioned helve hammers, finished in the best style, and most perfect in their action; also for originality in the combination of india-rubber pads with the hammer helve, whereby great flexibility and liveliness are imparted to the hammer, yet without shock, thus requiring less driving power than otherwise would be the case. Altogether, this firm have made a decided step in the construction of such hammers, and for certain classes of work they will be most valuable.

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33. Thos. Hall, Philadelphia, Pa., U. S.

PARALLEL VISES.

Report.—The parallel vises are of an ingenious construction, being capable of being used with facility in any desired position, and show excellent workmanship and practical arrangement.

34. **Bailey Wringing Machine Co., New York, N. Y., U. S.**

SIMPSON'S ADJUSTABLE PARALLEL VISES.

Report.—The collection of adjustable parallel vises are well and practically constructed.

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35. **Fisher & Norris, Trenton, N. J., U. S.**

DOUBLE SCREW PARALLEL VISES.

Report.—The large collection of double screw parallel "leg" vises and anvils are of very good material and workmanship.

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36. **James R. Luce, Stevens' Point, Wis., U. S.**

CIRCULAR SAW WITH MOVABLE TEETH.

Report.—A very ingenious, original, and efficient method of securing movable teeth in a circular saw for sawing lumber.

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37. **E. C. Atkins & Co., Indianapolis, Ind., U. S.**

CIRCULAR AND OTHER SAWS.

Report.—Circular saws of beautiful finish.

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38. **Simonds Manufacturing Co., Fitchburg, Mass., U. S.**

CIRCULAR SAWS.

Report.—Commended for circular saws of beautiful finish and form, and for originality in the method of manufacture.

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39. **American Saw Co., Trenton, N. J., U. S.**

MOVABLE-TOOTHED CIRCULAR SAWS.

Report.—For circular saws of high finish, and for the method of inserting detached teeth.

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40. **Henry Disston & Sons, Philadelphia, Pa., U. S.**

CIRCULAR AND OTHER SAWS.

Report.—Commended for good workmanship, for the practical tools for keeping saws in good order, and for the beauty of their general display.

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41. **First & Pryibil, New York, N. Y., U. S.**

BAND AND JIG SAWS AND WOOD-WORKING MACHINERY.

Report.—Commended for certain points of originality in connection with machinery for working wood; and also for the manner of constructing a heavy endless band sawing machine, in order to secure flexibility in the feeding arrangements and the attainment of great speed and adaptation for a variety of work; likewise for the combination of cheap yet thoroughly efficient materials in the elastic portion of the saw, whereby a soft, easy, and flexible motion is obtained at high speeds; as also for the simple manner in which an apparatus for copying busts or other forms has been constructed for the transforming of the likeness from a metal original to the piece of wood; and also for a self-acting saw-setting machine.

42. Bentel, Margedant, & Co., Hamilton, Ohio, U. S.

BAND AND JIG SAWS AND PLANING MACHINES.

Report.—Commended for originality in the introduction of a well-arranged slipping contrivance on the periphery of the upper band wheel of the endless saw machine, and for using an independently working double break; likewise for the introduction of an ingeniously contrived pair of steel springs to the "jig saw," which afford an easy motion with equal stretch of the saw blade, thus tending to permanence in efficiency; also for general excellence in the construction of a variety of planing machines for wood; for a trace of originality pervading the group; and especially for fitness for their intended purpose, and for the refinement displayed in the workmanship of the cutting instruments.

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43. Richards, London, & Kelley, Philadelphia, Pa., U. S.

BAND SAW AND WOOD-CUTTING MACHINERY.

Report.—Commended for great excellence of construction, simplicity, and solidity of parts; also for power of machines, and for points of ingenuity and originality of design. Special mention is deserved for the introduction and practical application of band saws for cutting timbers and re-sawing with power feed by friction wheels.

All the machines exhibited are of the highest credit to the workmanship of the firm, and all are exceedingly well fitted for their intended purpose.

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44. Jno. L. Knowlton's Estate, Sharon Hill, Delaware County, Pa., U. S.

JIG SAW.

Report.—Commended for the substantial construction of a "jig" sawing machine that is intended for sawing ship timbers, in which considerable originality is displayed in the various arrangements for convenient sawing of heavy timber on the skew or otherwise.

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45. Henry Lloyd Beach, Montrose, Pa., U. S.

FOOT AND POWER SCROLL-SAWING MACHINES.

Report.—Commended for cheapness, simplicity, speed, and efficiency.

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46. Trump Brothers, Wilmington, Del., U. S.

SCROLL SAW.

Report.—Commended as a cheap and conveniently combined machine for doing light scroll work.

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47. E. Andrews, Williamsport, Pa., U. S.

SAWS AND ATTACHMENTS.

Report.—This exhibit embraces several novelties, viz.: improvement in the construction of the hand saw handle; an improved "table" for mill saws; an improved "saw buckle," by means of which any evils arising from the irregularity of the internal strain of the saw itself are corrected with facility; an improved form of wood saw frame, made of sheet steel bent into a semi-elliptical cross section and curved as regards its length in such a way as to give a proper tension to the saw without the use of a brace or any tightening mechanism whatever; and a machine for sharpening and dressing circular saws, which possesses many novel peculiarities, among which may be named the safety elastic washers for holding the emery wheel employed.

48. Wicaco Screw Co., Philadelphia, Pa., U. S.

SCREWS AND CIRCULAR CUTTERS.

Report.—This firm shows a variety of specimens of beautiful screws, screwing taps, circular cutters, and other similar articles. The quality of all is very good.

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49. Wm. L. Conel, Rockford, Ill., U. S.

SAW SHARPENING MACHINE.

Report.—This machine is intended for sharpening the larger varieties of mill and circular saws. The ideas embraced in this machine are ingenious, and, when carried out in a more perfect manner as regards workmanship, will result in materially increasing the efficiency of lumber-producing machinery.

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50. Hewett & Follansbee, Washington, D. C., U. S.

SAW FILING AND SETTING MACHINE.

Report.—This firm exhibits a machine for filing and setting saws, which is adapted to sharpening and adjusting circular, band, frame, and hand saws of ordinary size. This machine appears to be well adapted for use in establishments for the manufacture of sashes, doors, blinds, furniture, and general wood work.

The ideas embraced in this exhibit are very ingenious and worthy of commendation, and the mechanical principles and workmanship are satisfactory.

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51. J. H. Cooper, Germantown, Philadelphia, Pa., U. S.

METHOD OF CHANGING CONTINUOUS CIRCULAR INTO INTERMITTENT MOTION.

Report.—He exhibits a method of changing continuous circular into intermittent circular motion. This invention is characterized by great originality and ingenuity, and differs from previous attempts to attain this end in that it accomplishes it without shock, and therefore admits of being run at great speed, in which respect it is an important improvement in motion of this character.

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52. E. W. Ross & Co., Fulton, N. Y., U. S.

AUTOMATIC CIRCULAR SAW MILL.

Report.—Commended for an admirably constructed circular saw mill with several important points of marked originality, more especially in the automatic horizontal feeding arrangement, which is highly to be commended; likewise for the various devices in connection with the carriage and its rapid execution. Altogether, this exhibit is of very high standard and most satisfactory in its practical workings.

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53. The Lane & Bodley Co., Cincinnati, Ohio, U. S.

PORTABLE CIRCULAR SAW MILL.

Report.—Commended for sound construction and good design of a circular saw mill, with quick return of the carriage, rapid cutting, and with the log clearing the saw on return motion.

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54. Chase Turbine Manufacturing Co., Orange, Mass., U. S.

CIRCULAR SAW MILL.

Report.—Commended for good construction of circular saw mill. The parallelism of the feed is well arranged, also the frictional driving arrangement, all evincing a trace of originality.

55. Stearns Manufacturing Co., Erie, Pa., U. S.

CIRCULAR SAW MILLS.

Report.—Circular saw mills of great excellence of construction and of first-class workmanship. Very convenient in arrangement and well fitted for rapid and economical execution.

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56. Lane Manufacturing Co., Montpelier, Vt., U. S.

CIRCULAR SAW MILL.

Report.—Commended for a portable circular saw mill, well arranged for convenience in working, for good workmanship, and for some evidence of ingenuity and originality.

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57. C. Meiners & Sons, Philadelphia, Pa., U. S.

BAND SAW MILL.

Report.—A band saw of inordinate dimensions. The saw is eight inches broad, and is driven at a velocity of sixty miles an hour.

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58. E. P. Allis & Co., Milwaukee, Wis., U. S.

SAW MILL MACHINERY.

Report.—Commended for good designs and general excellence in variously constructed sawing machines.

This exhibit is thoroughly practical, with speedy and convenient arrangements for shifting the position of circular saws upon their axes in edging machines. The entire plant is substantial, and adapted to great rapidity of execution and real efficiency. There are several points of originality in the details, and altogether it deserves high commendation.

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59. Morse Twist Drill and Machine Co., New Bedford, Mass., U. S.

TWIST DRILLS AND CIRCULAR CUTTERS.

Report.—Commended for the highest excellence and refinement of construction and quality in their own specialty of twisted drills, circular cutters, screwing, and other tools or instruments for the use of engineers, all of which are first-class. Their present exhibit is simply mechanical perfection.

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60. Hilles & Jones, Wilmington, Del., U. S.

RADIAL DRILLING MACHINES.

Report.—Commended for fair construction of radial drilling machines, suitable for boiler makers or similar class of work.

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61. C. Van Haagen & Co., Philadelphia, Pa., U. S.

DRILLS, DRILL ATTACHMENTS, DRILL GRINDERS, BORING TOOLS, AND SLIDE-REST.

Report.—With originality and ability in design, these tools and fittings to tools are well constructed, and are adapted to the wants of mechanics. They display fair workmanship, and are commended for their general utility and originality of design.

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62. Thorne, De Haven, & Co., Philadelphia, Pa., U. S.

PORTABLE DRILLING MACHINES.

Report.—The portable drilling machines exhibited by this firm are worthy of commendation for simplicity in construction, adaptability to the special class of work for which they are designed, and for the method of applying power to the machine by a novel con-

trivance which renders their management easy in all places and positions in which their use may be desired.

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63. **E. J. Worcester & Co., Worcester, Mass., U. S.**

PILLAR DRILLS.

Report.—Exhibit pillar drills designed to be worked by hand. These tools are characterized by convenience, compactness, and ingenuity of design, and, in the absence of power, will prove very useful in many small establishments for working metal.

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64. **C. A. & W. L. Teal, Philadelphia, Pa., U. S.**

PUNCHING AND SHEARING MACHINES.

Report.—Commended for strength and originality manifested in the construction of a combined punch and shear, as also in a lever punch, each of which is designed for use in boiler making and iron ship building.

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65. **J. H. Blaisdell, Philadelphia, Pa., U. S.**

UPRIGHT MOULDING AND SHAPING MACHINES.

Report.—These machines are simple and can be produced at a low price.
The upright moulder exhibited by this firm is a useful machine for several purposes.

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66. **The Howard Iron Works, Buffalo, N. Y., U. S.**

BOLT CUTTER (SCHLENKER'S PATENT).

Report.—Commended for ingenuity of idea in arrangements of movable dies in a machine for cutting bolts.

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67. **Stow & Burnham, Philadelphia, Pa., U. S.**

FLEXIBLE SHAFT FOR TRANSMITTING POWER.

Report.—Commended for originality, ingenuity, simplicity, durability, and perfect adaptability to the transmission of power to the work, thus obviating the necessity of bringing heavy work to the power. Capable of speedy and effective application to all drilling or boring tools.

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68. **Baxter D. Whitney, Winchendon, Mass., U. S.**

WOOD-WORKING MACHINERY.

Report.—These machines are constructed with the latest improvements in wood-working machinery. Particular notice is deserved by the scraping or smoothing machine; also by the machine for sharpening the edge of planing tools, and by the stave sawing machinery; also for originality in its details.

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69. **C. B. Rogers & Co., Norwich, Conn., U. S.**

WOOD-WORKING AND TIMBER-GAINING MACHINERY.

Report.—Boring, mortising, tenoning, planing, band and scroll saws, timber-gaining machine. Commended for excellence of execution and design, and for practical construction. The details of these machines are very well studied, and the different parts harmonize well together. Special mention is deserved by the timber-gaining machine, which is solid and powerful.

70. H. B. Smith, Smithville, N. J., U. S.

WOOD-WORKING MACHINERY.

Report.—A large collection of good, serviceable tools.

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71. J. S. Graham & Co., Rochester, N. Y., U. S.

WOOD-WORKING MACHINES, WITH TOOLS.

Report.—Commended for soundly constructed machines for double planing, and for good matching heads.

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72. J. A. Fay & Co., Cincinnati, Ohio, U. S.

WOOD-WORKING MACHINERY.

Report.—Commended for ingenuity of design and excellence of execution of all machines and tools exhibited. These machines all work exceedingly well. Special mention is deserved for the method of supporting the upper wheel shaft in band re-sawing machines, and for the facility of controlling and removing the tools during the work on planing and moulding machines, and especially for certain important points of originality.

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73. Greenwich Machine Works, Greenwich, N. Y., U. S.

WEAVERS' WOOD-WORKING MACHINES.

Report.—The machinery included in this exhibit is commended for the exceedingly original and effective method of communicating the power by means of a peculiar and novel combination of pulleys and belts.

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74. John W. Griffiths, New York, N. Y., U. S.

WOOD-BENDING MACHINE.

Report.—This machine, very useful to shipbuilders, is executed with solidity and simplicity. It has the advantage of being very powerful. Commended also for certain points of originality.

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75. E. & F. Gleason, Philadelphia, Pa., U. S.

WOOD-WORKING MACHINERY.

Report.—These machines are of remarkable simplicity and excellence in their design, solid and thoroughly practical in their construction, and will do good work, and contain several points of originality.

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76. Power, Tainter, & Co., Philadelphia, Pa., U. S.

WOOD-WORKING MACHINES.

Report.—These machines are well and substantially constructed, and adapted to their several purposes as wood-working machines.

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77. Goodell & Waters, Philadelphia, Pa., U. S.

WOOD-WORKING MACHINES.

Report.—Commended for practical and solid construction; facility of getting to the cutting parts of the machine.

Special mention is deserved by the contrivance which facilitates the easy removing of the moulding and matching tools.

78. Benj. Lawrence, Lowell, Mass., U. S.

COMBINED INDEX AND MILLING MACHINE.

Report.—This exhibit is an attempt to combine the essential parts of two machines in one, with a view to producing a machine that will meet the requirements of most jobbing shops, the extent of whose business would not justify the purchase of two machines, but still occasionally have need of means of executing work such as can be produced by this machine in an economical manner. It is a machine fairly meeting the conditions indicated above.

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79. Ferris & Miles, Philadelphia, Pa., U. S.

MACHINE TOOLS AND STEAM HAMMERS.

Report.—The exhibit of machine tools commended for carefully studied designs, thorough workmanship, originality, and accuracy. Of these tools deserving special mention is the sixteen-inch swing-lathe with an original screw-cutting gear, making thirty-two separate traverses without change of gear wheels.

The smaller sizes of slide lathes commended for an admirable positive feed gear of great simplicity, arranged to apply backward and forward or cross feed by a single movement of a convenient handle.

The car and locomotive axle lathes commended for solid and substantial construction, harmonious proportions, care displayed in the management of details, and for originality of design.

Shaping, drilling, and planing machines commended for general excellence and originality in design and construction, and for accuracy.

The steam hammers and drop deserve high commendation for the following reasons: The hammers are distinguished for strength of construction, excellent workmanship, and originality in the design of the valve motion, which is very flexible in its character, allowing the hammer to be worked automatically or by the hand of an assistant at pleasure. The valve is so arranged that all of the water entering the cylinder from the pipes is discharged through the exhaust post, which is located at the lowest part of the cylinder. The steam drop is designed for the production of what are known as drop forgings, and possesses a peculiarity in its valve gear which permits it to work continuously as a steam hammer, or confine its action to single and powerful blows, like an ordinary drop, at the pleasure of the operator. This, with other simple and original devices, renders the drop superior in range, power, convenience, and economy.

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80. Flather & Co., Nashua, N. H., U. S.

MACHINE TOOLS.

Report.—Commended for general excellence in good, sound, serviceable machine tools, and for the accuracy imparted to the more vital parts, where it is especially required. Also for certain points of originality shown in the various machines.

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81. Ames Manufacturing Co., Chicopee, Mass., U. S.

LATHES, DRILLS, AND OTHER MACHINE TOOLS.

Report.—Commended for great excellence in the design and construction of a variety of machine tools, with the best materials and workmanship throughout: more especially for the high sterling qualities of the smaller class of lathes, which are simply exquisite and rarely equaled; for originality in the spindle arrangements of drilling machines, which are very perfect; for a still higher order of originality that is displayed in the design of a remarkable machine for tracing copy and transferring, as in the profiling or die sinking, or other work of a similar character. The universality of the motions of certain parts of this

machine, and the refinement and accuracy of all its vital parts, are of a high standard. Altogether, this firm deserves high commendation for the marked superiority that pervades their whole exhibit, both for the general and the special tools.

82. F. Armstrong, Bridgeport, Conn., U. S.

LATHE DOGS AND BREAST DRILLS.

Report.—Exhibit a very creditable collection of lathe dogs and breast drills, which are deserving of commendation.

83. A. F. Prentice & Co., Worcester, Mass., U. S.

LATHES AND DRILLS.

Report.—This firm exhibits several small lathes and drills intended for light work, which are of very good design and workmanship.

84. Cornell University Machine Shop, Ithaca, N. Y., U. S.

FOOT LATHE, GAUGES, AND OTHER TOOLS.

Report.—This institution exhibits, as specimens of the work done by its engineering students, an amateur's foot lathe, which has several ingenious devices for facilitating work; and as a whole this tool is very creditable, both as to design and workmanship. It also exhibits a micrometer for measuring lengths up to twelve inches by variations of one ten-thousandth of an inch, which possesses several features of ingenious novelty, tending to augment the delicacy and general accuracy of its indications. It also shows a large variety of surface plates, straight edges, and angle plates, whose mathematical perfection leaves nothing to be desired. This exhibit is commended for its general ingenious and meritorious character, and as an evidence of the success of that method of study which combines the practical with the theoretical.

85. William Johnson, Lambertville Iron Works, Lambertville, N. J., U. S.

LATHE CHUCK.

Report.—For a substantial, original, and ingenious lathe chuck.

86. Bliss & Williams, Brooklyn, N. Y., U. S.

PRESSES AND LATHES.

Report.—This firm exhibits four power presses, two lever presses, and one spinning, trimming, and wiring lathe. These machines are characterized by great ingenuity of design, strength of parts, and perfection of workmanship. The press for making the covers of blacking boxes and other similar articles is especially efficient, cutting out the blank from a sheet of tin plate or other suitable metal, turning its edge, and, if desired, stamping an impression upon the cover, at one operation. Another of the presses shown is designed for cutting out and stamping baking pans of tin plate. These it produces with great rapidity ready for the finishing operation in the spinning, trimming, and wiring lathe, which smoothes the surface of the pan, trims, and finally turns over its edge in the form of a bead or wire before it leaves the machine. This exhibit embraces general excellence and solidity of design, quality of workmanship, and satisfactory performance of its intended work.

87. John Gleason, Philadelphia, Pa., U. S.

SPOKE AND HANDLE TURNING LATHE.

Report.—Commended for originality of design, ingenuity of arrangement, and adaptability to the purpose for which it is intended.

88. James Watson, Philadelphia, Pa., U. S.

GAP LATHE.

Report.—Commended for ingenuity of leading idea in design of a gap lathe.

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89. Oneida Steam Engine and Foundry Co., Oneida, N. Y., U. S.

LATHE CHUCKS.

Report.—Commended for originality of design and soundness of construction of chucks for lathes. The varied adaptation of these chucks is most ingenious, and the workmanship is first-class.

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90. Cooper, Jones, & Cadbury, Philadelphia, Pa., U. S.

LATHES.

Report.—Commended for excellence of construction in a lathe for finishing brass work. The various devices and arrangements that are introduced show considerable ingenuity and originality, and all the peculiarities of this lathe tend to efficiency and economy.

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91. Fitchburg Machine Co., Fitchburg, Mass., U. S.

LATHES AND DRILLS.

Report.—For excellence of general design in drilling machines with balanced spindle, quick return motion, and index showing the depth of penetration, without withdrawal of spindle.

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92. A. M. Benson, Cleveland, Ohio, U. S.

STAVE JOINTER.

Report.—Commended for simplicity in the construction of machinery for shaping staves of casks; also especially for several points of originality in connection therewith, both in regard to the principles of action and the manner in which they are applied.

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93. E. & B. Holmes, Buffalo, N. Y., U. S.

STAVE, BARREL, KEG, AND HOGSHEAD MACHINERY.

Report.—Commended for the ingenuity displayed in the contrivance of machinery for the manufacture of various descriptions of casks.

There is great mechanical skill shown in several of the combinations, more especially with reference to hooping and heading part of the plant. For the rougher class of casks these several tools show fitness for their intended purposes. The style of construction is not expensive.

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94. Peter Gerlach & Co., Cleveland, Ohio, U. S.

STAVE-SAWING MACHINE.

Report.—Commended for good workmanship and sound construction, in a stave-sawing machine which is conveniently adapted for its special purpose, with points showing originality.

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95. L. R. Palmer, Belfast, Me., U. S.

STAVE EDGING OR JOINTING MACHINE.

Report.—A serviceable machine for sawing the staves of casks.

96. Knapp Dovetailing Machine Co., Northampton, Mass., U. S.

DOVETAILING MACHINERY.

Report.—Commended for originality of idea in an entirely new system of joining wood, as in dovetailing, and for the manner in which the idea has been applied in the machine.

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97. R. I. Gould, Newark, N. J., U. S.

DOVETAILING MACHINE.

Report.—Commended for a new method of making dovetail by means of circular saws.

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98. Wm. F. Moody, Chicago, Ill., U. S.

DOVETAILING MACHINE.

Report.—This machine is characterized by great originality of idea, and it performs its work in a very satisfactory manner.

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99. Martin Buck, Lebanon, N. H., U. S.

SLAT PLANER AND WEDGE-MAKING MACHINE.

Report.—This exhibit includes a machine for planing blind-slats on both sides at once; also a machine for cutting wedges and pins, and a machine for mortising blind-stiles. All these machines are characterized by great originality and satisfactory performance.

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100. A. J. Wilkinson, Boston, Mass., U. S.

PLANING MACHINE AND LATHES.

Report.—Commended for the excellent construction of a power planing machine of small dimensions, in which respect it is probably unique; also for two neatly-constructed lathes of the small class. The whole is of good workmanship.

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101. S. A. Woods Machine Co., Boston, Mass., U. S.

WOOD PLANING AND MOULDING MACHINES.

Report.—Commended for excellent construction of exhibited machines; general convenience. The workmanship is very superior, and they do their work most efficiently. Especially recommended for the so-called combination planer, and the planing machine with diagonal cylinder, and for certain points of originality.

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102. Hendry Machine Co., Wolcottville, Conn., U. S.

PLANING MACHINE.

Report.—Commended for good construction of small planing machines, variously arranged, with a trace of originality in some of the details. These tools are characterized by fairly good workmanship, and are conveniently arranged for the lighter class of work.

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103. Old Colony Rivet Works, New York, N. Y., U. S.

PLANING AND SHAPING MACHINE.

Report.—Commended for simplicity, labor-saving qualities, portability, and for its adaptability to a considerable range of work; and also for its cheapness.

104. Isaac P. Richards, Providence, R. I., U. S.

PUNCHES.

Report.—Commended for good construction of punches in regard to design and workmanship, and for the economical and satisfactory manner in which the punches are held.

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105. A. H. Merriman, West Meriden, Conn., U. S.

POWER PUNCHING PRESS.

Report.—He exhibits a power press, or punch, which is a well-made, substantial machine and contains several features of marked originality which materially augment its durability and efficiency.

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106. Walker Brothers, Philadelphia, Pa., U. S.

PANELING MACHINE AND POWER SAW.

Report.—Commended for simplicity in construction, and for the great range of work to which it is adapted; also for serviceableness of scroll saw.

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107. Battle Creek Machine Co., Battle Creek, Mich., U. S.

BOULT'S CARVING, PANELING, MOULDING, AND DOVETAILING MACHINE; SOLID STEEL CUTTERS.

Report.—Commended for ingenious conception and for practical execution of a machine for dovetailing and moulding, whose construction is cheap, considering the variety and the quality of the work yielded; also for solid steel cutters; also for an ingeniously arranged dovetailing machine, operated separately from above.

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108. Douglass Manufacturing Co., Seymour, Conn., U. S.

MECHANICS' EDGE TOOLS AND BORING IMPLEMENTS FOR WOOD.

Report.—Commended for a good collection of tools, and good workmanship.

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109. Greenlee Brothers & Co., Chicago, Ill., U. S.

SASH, BLIND, AND DOOR-CLAMPING MACHINES.

Report.—Commended for solidity in clamping machines, for originality in the details, and for adaptability to the purpose for which they are designed.

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110. C. S. & S. Burt, Dunleith, Ill., U. S.

SHINGLE MACHINE.

Report.—Commended for great simplicity of design, solidity of construction, great power of production, and great originality.

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111. Roswell Hart, Rochester, N. Y., U. S.

MACHINES FOR HALF-ROUND HOOPS FOR BARRELS.

Report.—These machines are characterized by great originality of idea, and are believed to be the first successful machines for the manufacture of wooden hoops. The machines are constructed in a solid and practical manner, and are well adapted to the purpose for which they are intended, and will turn out their product with rapidity and great economy in the use of new material and the manual labor employed.

112. Silver & Deming Manufacturing Co., Salem, Ohio, U. S.

HUB-BOXING AND SPOKE-TENONING MACHINES, AND HOLLOW AUGER.

Report.—Commended for ingenious and practical construction of tools for making carriage- and wagon-wheels by hand. These tools are very convenient for small workshops where hand-power is employed.

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113. Howard Manufacturing Co., Belfast, Me., U. S.

MITER MACHINES.

Report.—These machines do their work very nicely; they are of great value for cabinet-makers, joiners, and all working with hand-power.

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114. The Lane & Bodley Co., Cincinnati, Ohio, U. S.

VARIABLE STROKE POWER MORTISERS.

Report.—These combined boring and mortising machines, one of them with self-reverser, are ingenious in design and well constructed, and show points of originality.

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115. Empire Portable Forge Co., Troy, N. Y., U. S.

PORTABLE FORGE.

Report.—Commended for samples of a very compact and convenient portable forge that is well calculated to meet the needs of those who require a forge that can readily be transported; and for general convenience and portability.

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116. Alexander Kempt, Eau Claire, Wis., U. S.

TEMPORARY RUDDERS FOR RAFTS AND RIVER BOATS.

Report.—Commended for an ingenious contrivance for temporary rudders for the controlling of rafts and boats in rivers. The rudders are placed in convenient positions on the sides of the raft or boat, and are manipulated simultaneously by one man by means of a rope and windlass, the current of the river being the agent to give transverse motion to the raft or boat in either direction as may be required.

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117. Wm. B. Burk & Co., Philadelphia, Pa., U. S.

CORK MACHINERY.

Report.—Cork machinery, characterized by simplicity and efficiency.

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118. Armstrong Brothers & Co., Pittsburg, Pa., U. S.

CORK CUTTER AND TAPERING MACHINES.

Report.—Commended for simplicity with great power of production.

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119. Knickerbocker Ice Co., Philadelphia, Pa., U. S.

ICE TOOLS AND ICE MACHINERY.

Report.—The tools exhibited are eminently fit for the preparation and cutting of thick and strong as well as thin ice. They are excellent in design, and of the most admirable workmanship. It must be added, moreover, that all the working surfaces of the exhibited tools are of steel. The tools for handling and transporting the ice are also of excellent design and workmanship.

120. H. F. Dernell & Co., Athens, N. Y., U. S.

ICE TOOLS.

Report.—The several tools exhibited for the preparation, breaking, and storing of ice are exquisitely and beautifully finished, and made of excellent material. The improvements made by this exhibitor in his tools are very practical, and the workmanship excellent.

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121. War Department, Ordnance Section, Washington, D. C., U. S.

CARTRIDGE AND GUN MAKING MACHINERY.

Report.—The machine tools of the Ordnance Section are arranged in such a manner as to show the successive phases of their working order. They are very remarkable for their harmonious proportions, pleasing forms, and the extreme simplicity of their different parts; and especially for the means of regulating them, which may be called perfect.

The United States Government is to be congratulated on showing to the world such perfect machines, due to the inventive minds and learned and thorough research of their engineers.

The high qualities which distinguish the American gun, notably its precision in firing and range, are the most convincing proofs of the almost mathematical correctness and of the excellent adjustment of the pieces made by the machines of the Ordnance Section.

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122. Thomas Gadd, Manchester, England.

TOP-PRESSURE ENGRAVING MACHINE.

Report.—Commended for originality of design and excellence of construction, in a top-pressure engraving machine for transferring an engraved or other pattern from a hardened steel copy to the surface of the copper rollers used in the calico printing machine; also for originality shown in the several devices for varying the mode of action, whether by milling or compression by impact, and for the combining of the two systems in one machine.

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123. Fairbairn, Kennedy, & Naylor, Leeds, England.

QUADRUPLE DRILLING MACHINE.

Report.—Commended for the substantial construction of a quadruple drilling machine, so arranged as to enable one man conveniently to manage four independent drills to be used for a class of articles that have to be repeated in locomotive and wagon work.

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124. Beesley & Sons, Barrow in Furness, England.

PUNCHING AND SHEARING MACHINE.

Report.—Commended for originality in the arrangement of a punching and shearing machine, whereby it is equally adapted for punching and the ordinary shear, as also for the shearing of angle bars without inconvenience.

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125. Turner & Co., England.

SMITHS' TOOLS.

Report.—Commended for good quality in smiths' anvils, vises, and other tools that are used in smithies.

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126. B. & S. Massey, Openshaw, Manchester, England.

STEAM HAMMERS AND DROPS.

Report.—Commended for excellence and harmony in design, and for the general soundness of construction, shown in a variety of steam hammers, all admirably adapted for the

different classes of work for which they are severally intended. These hammers are of all sizes, from the smallest up to five tons. These steam hammers are also distinguished for great structural solidity, and for simplicity in the motions for working the hammers, either by hand or automatically, and likewise for originality in some of the details that contribute to efficiency.

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127. Brooks & Cooper, Sheffield, England.

ANVILS.

Report.—Commended for good sound quality and form of variously-shaped anvils used for different purposes in the practical arts.

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128. William Roberts, Bootle, near Liverpool, England.

PAINTING MACHINE FOR WOOD LATHS.

Report.—Commended for simplicity in the construction of a machine for painting laths, whereby efficiency combined with economy is effected.

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129. Joshua Heap & Co., Oldham, England.

PIPE AND BOLT SCREWING MACHINE.

Report.—Commended for good design and sound construction, in a variety of small machines that are employed for screwing pipes and other articles, whereby rapidity of execution combined with efficiency is secured; also for originality in some of the details.

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130. Peter Wright & Sons, Dudley, Worcestershire, England.

ANVILS AND VISES.

Report.—An exhibit of a very satisfactory collection of anvils and vises, which are commended for general excellence of design and workmanship.

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131. Greenwood & Batley, Leeds, England.

BOLT-HEADING MACHINE.

Report.—Commended for excellence of design, and for general soundness of construction, in a machine for heading bolts, or for a variety of other work, by means of a power hammer with dies; also for originality in regard to the detail arrangements, and for convenience and efficiency.

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132. Hugh Shearer, London, England.

STONE-DRESSING MACHINE,—HOLMES'S PATENT.

Report.—Commended for good design and general soundness of construction in a machine for dressing stone, which answers the purpose admirably and economically. The machine is conveniently arranged, and contains several points showing originality; and, as a whole, this machine is deserving of commendation.

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133. Robert Martin, Old Charlton, Kent, England.

CIRCULAR CUTTERS.

Report.—Commended for superior workmanship in small tools of the class known as circular cutters. These tools are used in the manufacture of the multiple shearing instrument for clipping horses, and show refinement with precision.

134. **R. H. Smith & Co., St. Catharine's, Ontario, Canada.**

CIRCULAR SAWS.

Report.—Beautiful circular saws, of high finish.

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135. **Mitchell & Taple, Harriston, Ontario, Canada.**

WOOD-SAWING MACHINE.

Report.—This machine is commended for its simplicity, handiness, and portability, as one horse power drives it. It is used with advantage in remote places for cutting stove wood and shingle baulks out of round logs.

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136. **Waterous Engine Works Co., Brantford, Ontario, Canada.**

PORTABLE SAW-MILL.

Report.—A portable saw-mill of good construction, most conveniently arranged for portability, and, from the manner in which it has been designed, this saw-mill is not expensive.

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137. **J. F. Fisher & Co., Kincardine, Ontario, Canada.**

CLIPPING BOILER-PLATE MACHINE.

Report.—This firm exhibits two machines which are similar but on different patterns. They are simple, very handy, and can be operated by the most inexperienced workman; besides which, they may be commended for their powerful effects and for the quality of work produced.

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138. **McKechnie & Bertram, Dundas, Ontario, Canada.**

WOOD-MOULDING MACHINE AND RADIAL DRILL.

Report.—A variety of machine tools for the working of metal and wood; also originality shown in the design of a radial drilling machine, whereby the spindle may be placed at any angle within certain limits; likewise for general convenience and soundness of structure in a machine for planing wood, which is a remarkably good tool for its intended purpose.

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139. **R. Mitchell & Co., Montreal, Canada.**

LEAD TUBE BENDING MACHINE.

Report.—Commended for ingenuity and originality in the design of a machine for the formation of bends and crooks in lead pipes.

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140. **Browne & Howe, St. John, N. B., Canada.**

TURNING LATHE.

Report.—The machine shows an ingenious, simple, and new disposition of the working tools, with rapid and various effects.

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141. **William M. Kennedy & Sons, Owen Sound, Ontario, Canada.**

FACING AND JOINTING MACHINE.

Report.—A machine which is simple and handy, and gives good results as to the character of the work performed.

142. Practical Technological Institute, St. Petersburg, Russia.

SMALL MACHINE TOOLS, AND SPECIMENS OF WORK.

Report.—Commended for the refinement and general excellence of construction displayed in a variety of small machine tools. The workmanship is very superior, and the system of teaching is well fitted to impart good, sound mechanical instruction to the students. For a number of specimens showing skill and good sound workmanship of a high class.

Great credit is due to the professors for the progress made since the Vienna Exhibition of 1873, as well as to the students and all concerned in the school.

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143. Imperial Technical School, Moscow, Russia.

ENGINEERING TOOLS USED IN TEACHING.

Report.—For an interesting display of tools that are used in teaching practical engineering to students, more especially in the class of tools called scribers, which are variously arranged. Much ingenuity has been bestowed upon some of the details, in order to make sure of the fixing and to avoid the possibility of error.

Also great praise is due to the professors for the admirable system which has been intro duced into the Technical School, and likewise to the students for the excellence of their workmanship.

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144. Cronstadt Navy Yard, Cronstadt, Russia.

CHAIN CABLES.

Report.—Commended for admirable smith work shown in the several specimens of chain cables exhibited, in which are illustrated every variety of work usually seen in connection with heavy chains, including "swivels," "shackles," and "connecting eyes," all exceedingly well proportioned, and executed in a manner to challenge the admiration of every one familiar with such work.

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145. Gustavus Lessner, St. Petersburg, Russia.

RADIAL DRILLING MACHINE LATHE.

Report.—Commended for excellence of construction shown in two grand machine tools, namely, a radial drilling machine and a heavy lathe adapted especially for turning locomotive wheels. The materials and workmanship are both first-class.

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146. F. Arbey, Paris, France.

WOOD-WORKING MACHINES.

Report.—An exhibit of nine machines, three of which are original in construction. They are all admirable for their simplicity combined with solidity and elegance, and for the harmony of the whole. They are handy, and not subject to breaking and stopping. Special mention is deserved for the planer with helical knives and permanent sharpening apparatus; also for the stave-cutting machine especially built with the view to economize wood; and the little lathe for copying sword handles and similar small articles.

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147. Société Anonyme des Ateliers de la Dyle, Louvain, Belgium.

IRON FORGED RAILWAY WHEELS.

Report.—Commended for a large collection of iron forged railway carriage wheels, of various patterns, belonging to railways of nearly all nations.

148. Auguste de Tombay, Marcinelle, near Charleroi, Belgium.

STEAM HAMMERS AND SHEARING MACHINE (MODELS).

Report.—Models, one-fourth size, of steam hammers and shearing machines. The design of the hammer framing is very superior, and the workmanship of both tools is first-class.

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149. The National Mint, Rio de Janeiro, Brazil.

STAMPING AND EDGING MACHINES.

Report.—Commended for excellence in the design and construction of mint machinery, both for coining or stamping and for edging the coin. The various arrangements are well carried out, and the workmanship is of superior quality.

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150. Kahlke & Detlefsen, Hamburg, Germany.

TOOTH-CUTTING MACHINE.

Report.—Commended for originality in the devising of an entirely new machine for cutting the teeth of small bevel wheels or pinions, by means of the well-known circular cutter, the mechanism being so arranged as to impart an oscillating motion to the cutter while it revolves, thus giving the proper shape to the teeth, and with the lines of surface directed to the mathematical point where the cones meet, or capable of being so constructed.

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151. Schaffer & Buddenberg, Buckau, near Magdeburg, Germany.

METAL-GRINDING MACHINE.

Report.—Commended for originality in the contrivance of grinding machine for metal by a simple addition to the mechanism.

The work-table is depressed on its return movement, in order that the grinding wheel may run clear of the work under operation, and is thereby less exposed to injury from contact and the danger arising from fracture of the emery wheel.

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152. A. Borsig, Berlin, Prussia, Germany.

FORGINGS IN IRON.

Report.—This exhibit embraces a large variety of samples of forging of complicated forms in iron, including axle-boxes for locomotives, cross heads, cranks, parts of wheels, pistons, manhole rims, etc., etc., all made in dies by means of the Haswell hydraulic forging press, and are splendid specimens of the art of producing irregular forgings in dies.

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153. Fried. Krupp, Essen, Prussia, Germany.

CAST-STEEL FORGINGS.

Report.—A superb sample of cast-steel forging in the rough state in the form of a "three-throw" crank shaft with coupling flange on one end. The weight of this very superior specimen of the art of forging is thirty thousand pounds, and the workmanship displayed in the execution of this very difficult piece of forged work is deserving of the very highest commendation.

There is also shown a double crank shaft with coupling flange. This shaft is of crucible cast steel, finished ready for its intended service, and is an exceedingly fine specimen of forged and finished work in steel. Its weight is twenty thousand pounds. Included in this exhibit of forgings in steel are a large number of pieces of lighter weight than those before mentioned, such as piston rods, railway axles, coupling rods, slide bars, etc., which are excellent samples of workmanship. There are also shown some specimens of forged work

in wrought iron, produced by means of the Haswell forging press, which are very satisfactory samples of the capacity and power of this rival of the steam hammer.

Taken as a whole, this exhibit of forged work is of unusual excellence and of great instructive value.

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154. Stridsberg & Björk, Holmen, Torshälla, Sweden.

CIRCULAR SAWS.

Report.—Circular saws of fine finish.

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155. Sandvikens Iron Works Co. (Limited), Gefle, Sweden.

CIRCULAR SAWS.

Report.—Circular saws of beautiful finish.

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156. Köping's Mechanical Works, Köping, Sweden.

SLIDE LATHE.

Report.—Commended for good sound construction of an eight-inch slide lathe, adapted for screw cutting and suitable for general work.

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157. J. & C. G. Bolinder, Machine Manufacturing Co., Stockholm, Sweden.

SAWING MACHINERY AND METAL-CARTRIDGE MACHINES.

Report.—Commended for good designs and excellence of construction in a variety of sawing machinery, which are all conveniently arranged and put together in a sound and substantial manner; also, and more especially, for ingenuity shown in the contrivance of a series of machines for cartridge manufacture. Many of the devices employed are cleverly arranged in their details to insure a good result. The whole exhibit is interesting and instructive.

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158. Sandvikens Iron Works Co. (Limited), Gefle, Sweden.

BESSEMER STEEL FORGINGS.

Report.—The principal part of the exhibit of this company does not come within the scope of the duties of the judges of Group XXI., but they are the exhibitors of a splendid collection of forgings in Bessemer steel, comprising a large variety of specimens, among which must be named a finished piston rod, weighing five tons, for a large steam hammer, a shaft partially finished, weighing three and one-half tons, a double-throw crank axle, weighing three tons, a crank axle for inside connective locomotive, together with several smaller specimens in the form of cranks, cross heads, piston rods, connecting rods, etc., etc., all of Bessemer steel, and as specimens of the satisfactory execution of difficult forging in steel are of great excellence.

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159. Fagersta Bruk, Fagersta Iron and Steel Works, Westanfors, Sweden.

FORGINGS IN STEEL.

Report.—A large variety of forgings in steel, including a double-throw crank axle for a locomotive, a single-throw crank axle with coupling flange, and sundry railway axles, cross heads, and connecting rods, all of very satisfactory and commendable quality as samples of the art of producing difficult forgings in steel.

SIGNING JUDGES OF GROUP. XXI.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

W. F. Durfee, 1, 3, 4, 5, 6, 7, 14, 16, 18, 20, 22, 25, 26, 27, 36, 47, 49, 50, 51, 63, 64, 66, 73, 78, 82, 83, 84, 85, 86, 88, 98, 99, 105, 111, 115, 130, 144, 152, 153, 158, 159.

Geo. H. Bleloch, 2, 15, 28, 62, 79, 103, 106.

John Anderson, 8, 9, 10, 11, 12, 17, 19, 23, 24, 29, 30, 31, 37, 38, 39, 41, 42, 44, 48, 52, 53, 54, 55, 56, 57, 58, 59, 60, 80, 81, 89, 90, 91, 92, 93, 94, 95, 100, 102, 104, 109, 116, 117, 122, 123, 124, 125, 127, 128, 129, 131, 132, 133, 134, 136, 138, 139, 142, 143, 145, 148, 149, 150, 151, 154, 155, 156, 157.

C. A. Angstrom, 13, 32, 61, 126.

Aug. Gobert, fils, 21, 40, 65, 75, 76, 96, 108, 118, 147.

F. Reifer, 33, 34, 35, 43, 68, 69, 71, 72, 74, 77, 87, 97, 101, 107, 110, 112, 113, 114, 119, 120.

John A. Anderson, 45, 46, 67, 70.

F. Perrier, 121, 135, 137, 140, 141, 146.

SUPPLEMENT TO GROUP XXI.

REPORTS
OF
JUDGES ON APPEALS.

JUDGES.

JOHN FRITZ, Bethlehem, Pa.
EDWARD CONLEY, Cincinnati, Ohio.
CHARLES STAPLES, JR., Portland, Me.
BENJ. F. BRITTON, New York City.
H. H. SMITH, Philadelphia, Pa.
COLEMAN SELLERS, Philadelphia, Pa.
JAMES L. CLAGHORN, Philadelphia, Pa.
HENRY K. OLIVER, Salem, Mass.
M. WILKINS, Harrisburg, Oregon.
S. F. BAIRD, Washington, D. C.

1. D. L. Kennedy, New York, N. Y., U. S.

SPIRAL PUNCHES AND PORTABLE PUNCHING AND SHEARING MACHINES.

Report.—Spiral punches, specimens well made. Commended for utility and fitness for intended use.

"Concentrated power" punching and shearing machines. Commended for ease of working, and utility.

2. A. Weed, Philadelphia, Pa., U. S.

FILE-CUTTING MACHINE.

Report.—Fitness for use intended.

3. David McFarland, Worcester, Mass., U. S.

ADJUSTABLE SCREW WRENCHES AND VERTICAL HAND-DRILLING MACHINES.

Report.—Commended for the convenience and strength of the wrenches, and their adaptability to various purposes; the convenience and general usefulness of the drilling machines.

4. C. W. Coe, Fenton, Mich., U. S.

PORTABLE HAND-DRILL AND BOLT-CUTTING MACHINE.

Report.—Commended for ingenuity of feed motion, simplicity, and adaptability of machine to its use.

5. The E. Horton & Son Co., Windsor Locks, Conn., U. S.

LATHE CHUCKS.

Report.—Commended for intrinsic excellence in workmanship, material, and adaptability to the uses for which they are intended.

6. American File Co., Pawtucket, R. I., U. S.

FILE-TESTING MACHINE.

Report.—Commended for simplicity and efficiency.

---

7. C. Scofield & Co., Vineland, N. J., U. S.

SHAFT STRAIGHTENER.

Report.—Commended for simplicity, efficiency, and judicious application of power to effect its purpose.

---

8. Morris L. Orum, Philadelphia, Pa., U. S.

FLEXIBLE MANDRELS FOR BENDING METALLIC TUBING.

Report.—An original and very creditable invention, displaying considerable ingenuity, and deserving commendation for its labor-saving qualities, and for producing results in tube bending that have never been obtained by any of the old methods.

---

9. Jose Baptista, Oporto, Portugal.

LATHE FOR GEOMETRIC TURNING.

Report.—Commended for very good workmanship and ingenuity of construction.

SIGNING JUDGES OF SUPPLEMENT TO GROUP XXI.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

COLEMAN SELLERS, 1, 2, 4, 9.
CHAS. STAPLES, JR., 3, 5, 6, 7.
JAMES L. CLAGHORN, 8.

United States Centennial Commission.

INTERNATIONAL EXHIBITION,

1876.

REPORTS AND AWARDS

GROUP XXII.

EDITED BY

FRANCIS A. WALKER,

CHIEF OF THE BUREAU OF AWARDS.

PHILADELPHIA:

J. B. LIPPINCOTT & CO.

1878.

SYSTEM OF AWARDS

[*Extract from Circular of April* 8, 1876.]

Awards shall be based upon written reports attested by the signatures of their authors.

The Judges will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the Commission of each country and in conformity with the distribution and allotment to each, which will be hereafter announced. The Judges from the United States will be appointed by the Centennial Commission.

* * * * * * * * * * *

Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Each report will be delivered to the Centennial Commission as soon as completed, for final award and publication.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress, and will consist of a diploma with a uniform Bronze Medal, and a special report of the Judges on the subject of the Award.

Each exhibitor will have the right to produce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

ORGANIZATION AND DUTIES OF THE JUDGES.

[*Extract from Circular of May* 1, 1876.]

Two hundred and fifty Judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the Groups to which they have been respectively assigned. The foreign members of this body have been appointed

by the Commission of each country, in conformity with the distribution and allotment to each, adopted by the United States Centennial Commission. The Judges from the United States have been appointed by the Centennial Commission.

To facilitate the examination by the Judges of the articles exhibited, they have been classified in Groups. To each of these Groups a competent number of Judges (Foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the Departments of Agriculture and Horticulture, which will form temporary exhibitions, have been arranged in special Groups, and Judges will be assigned to them hereafter.

The Judges will meet for organization on May 24, at 12 M., at the Judges' Pavilion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

The Judges assigned to each Group will choose from among themselves a Chairman and a Secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a Judge in each Group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed, by a majority of the Judges in such Group.

The reports of the Judges recommending awards based on the standards of merit referred to in the foregoing System of Awards, must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the Judges on the subject of the Award, together with a Diploma and a uniform Bronze Medal.

Upon matters not submitted for competitive trial, and upon such others as may be named by the Commission, the Judges will prepare reports showing the progress made during the past hundred years.

Vacancies in the corps of Judges will be filled by the authority which made the original appointment.

No exhibitor can be a Judge in the Group in which he exhibits.

An exhibitor, who is not the manufacturer or producer of the article exhibited, shall not be entitled to an award.

The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the Judges. Upon request, he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the Commission relating to awards, subject to an appeal to the Commission.

A. T. GOSHORN,
Director-General.

[*Extract from Director-General's Address to Judges, May 24,* 1876.]

"The method of initiating awards which we have adopted differs in some respects from that pursued in previous exhibitions. In place of the anonymous verdict of a jury, we have substituted the written opinion of a Judge. On this basis awards will carry the weight and guarantees due to individual personal character, ability, and attainments, and to this extent their reliability and value will be increased. It is not expected that you will shower awards indiscriminately upon the products in this vast collection. You may possibly find a large proportion in no way raised above the dead level, nor deserving of particular notice. The standard above which particular merit worthy of distinction begins is for you to determine. In this regard I have only to express the desire of the Centennial Commission, that you should do this with absolute freedom, and when you meet with a product which you consider worthy of an award, we desire you to say, in as few words as you may deem suitable, why you think so.

"This, gentlemen, is all we ask of you in the Departments of Awards. Opinions thus expressed will indicate the inherent and comparative merits, qualities, and adaptations of the products,—information which the public most desires.

"Elaborate general reports and voluminous essays, though of great value as sources of general information, give little aid in determining the reliable or intrinsic merits of particular, individual products.

"The regulations which have been published divide the work of awards into three parts:

"1st. The individual work of the Judges.

"2d. The collective work of the groups of Judges.

"3d. The final decisions of the United States Centennial Commission in conformity with the acts of Congress.

"Each award will thus pass three ordeals, which, doubtless, will be ample and satisfactory."

GROUP XXII.

JUDGES.

AMERICAN.

GEORGE W. GREGORY, Boston, Mass.

EDWARD H. KNIGHT, A.M., Washington, D. C.

L. D. F. POORE, Springfield, Dakota.

FOREIGN.

FRED. A. PAGET, C.E., Great Britain.

GROUP XXII.

MACHINES, APPARATUS, AND IMPLEMENTS USED IN SEWING AND MAKING CLOTHING, LACE, ORNAMENTAL OBJECTS, PINS, ETC.

CLASS 530.—Machines used in the manufacture of tapestry, including carpets, lace, floor-cloth, fancy embroidery, etc.

CLASS 531.—Sewing and knitting machines; clothes-making machines.

CLASS 534.—Machines for ironing, drying, and scouring.

CLASS 535.—Machines for making clocks and watches.

CLASS 536.—Machines for making jewelry.

CLASS 537.—Machines for making buttons, pins, needles, etc., and for sticking pins upon paper.

GENERAL REPORT

OF THE

JUDGES OF GROUP XXII.

INTERNATIONAL EXHIBITION,
Philadelphia, 1876.

PROF. F. A. WALKER, *Chief of Bureau of Awards:*

SIR,—I have the honor to transmit herewith the report of the Judges of Group XXII., relating to Machines used in Sewing and Making Clothing.

Very respectfully yours,

EDWARD H. KNIGHT.

GROUP XXII.

MACHINES, ETC., USED IN SEWING AND MAKING CLOTHING.

BY GEORGE W. GREGORY.

Nearly all the important mechanical improvements of the century are recorded in forms of patent grants, and from such sources it is possible to derive a very correct history of any of the modern mechanical arts or industries. The following statement as to the art of sewing is based upon items derived from patent records and trials in the United States courts, and it aims to give the proper share of credit to inventors of elements now actually considered necessary in every first-class or practical sewing-machine.

On June 24, 1775, a patent was granted in England for a needle having a point at each end and a centrally-located eye. It was to be used for "working fine threads into muslin after the manner of Dresden needle-work,"—a class of embroidery. The object of the two points was to prevent turning the needle end for end after its passage through the material. It is not believed that this needle was then used for sewing purposes, nor was such a needle used for machine-sewing until after the year 1790. On September 17, 1790, one Thomas Saint, of Greenhills Rents, in the Parish of St. Sepulchre, Middlesex County, England, a cabinet-maker by trade, received a patent for "An entire new method of making and completing shoes, boots, spatter-dashes, etc., and of certain compositions of the nature of japan or varnish, which will be very advantageous in many useful applications." This Saint patent describes and shows, in a crude drawing, a sewing-machine to automatically form a chain-stitch. The inventor conceived the idea that a seam might be sewn without passing the whole of the needle entirely through the material, and that a loop of thread might be pushed through the materials to be secured by stitches,—a hole being first made by means of an awl,—and that each loop pushed through the material might be caught and held open by a hook while the material was moved for a new stitch, each

succeeding loop, after passing through the material, also passing through the loop previously formed and then held by the hook. This looping of the stitches resulted in the production of a seam in which each loop was locked by or enchained with a subsequent loop, forming what is now known as the chain or single-thread stitch, such, for instance, as that made on the Wilcox & Gibbs sewing-machine. The needle employed by Saint was notched or forked at its lower end to span the thread and push it through the material. A needle, such as shown in the Saint patent, might be made by cutting an ordinary eye-pointed needle at right angles to its axis and through the centre of the eye. The Saint patent shows a horizontal supporting surface, or "slide," to receive the material to be stitched, and the "slide" is provided with a screw moved after each stitch so as to advance the "slide" and material thereon for a new stitch. The drawing and description of the Saint patent are insufficient to enable one, without considerable invention, to construct a machine to form stitches, and even then it could not sew a seam longer than the length of the slide without stopping the machine and returning the slide to its first position. The material could not be moved by the slide without being fixed to it, and in such case the seam could be only in the direction of the movement of the slide.

In machines employing an eye-pointed needle for sewing, it is necessary to employ a presser-foot to press the material upon the supporting surface as the needle rises, and to keep the fabric against the feed and on the supporting surface; and the feeding surface must be used in connection with an adjacent cloth-supporting surface to receive the sewn material, or else the feed cannot be made to move the cloth freely in any desired direction. Saint's machine had not a presser, nor an equivalent for it, nor had it a receiving-plate for the stitched material. With our present knowledge of sewing-machinery, gained by familiarity with subsequently perfected inventions, we can but look back with wonder at the Saint patent, for the ideas therein contained disclose many of the germs of the perfected sewing-machine of the present day. Saint's patent is No. 1764 for 1790, and can be seen in any library having English patents.

In the history of the sewing-machine Thomas Saint must occupy the foremost position of honor as its conceiver; yet, in according to him this position, it must be remembered that to other and equally original inventors, who re-invented and in a better manner what he crudely conceived and which had been forgotten, belongs no small share of honor, for they perfected and adapted the sewing-machine to the wants of the people. An idea does not arrive to the

full dignity of an invention until it is developed in practical form, ready to successfully aid man in his labor, and until it is capable of producing work satisfactory for the purpose intended. When a machine performs good work it then, and not until then, becomes a labor-saving machine.

Saint may be considered the first to conceive that a seam might be formed from a continuous thread contained upon a spool; the first to suggest a horizontal supporting surface to resist the thrust of the needle; the first to push a loop through the material by only a partial passage of the needle; and the first to suggest that the material might be moved automatically after each stitch.

Messrs. Newton, Wilson, & Co., of London, England, had among their collection of machines one purporting to have been made in accordance with the Saint patent; but it was necessary to change the construction of some parts, and invent others, before the devices would sew. This reproduction of the Saint machine was not, however, in working order.

The next machine in the order of inventions is described in an English patent to John Duncan, No. 2769, May 30, 1804. It employed a series of hooked needles, each supplied with thread from a thread-carrier after passing through the material, and each then drew its thread through the material in the form of a loop and held it while the material was moved automatically according to the pattern to be wrought, when each needle again penetrated the material, and again drew a loop through the material, and through the loop then held on its shank. The material was stretched between two parallel rollers, placed in an oblong frame, free to slide up and down within a horizontally movable frame. This machine made a chain-stitch by drawing a loop through the material, instead of pushing it through as described by Saint, and was used for "tambouring upon cloth."

English patent No. 3078, October 30, 1807, is the first to show an automatically operated contrivance, with an eye-pointed needle to carry a thread through the articles to be bound together. The apparatus therein described shows two eye-pointed, thread-carrying, perforating needles, each held in a reciprocating needle-bar. The needles are designed to unite several small ropes laid parallel to form a broad, flat rope. One eye-pointed needle is made to push a thread through these several small ropes. When the needle penetrates through all the ropes, and its eye passes beyond the last rope, the thread (used in short lengths) is removed or unthreaded from the eye, the needle is drawn back and out from the ropes, and the thread is then placed in the eye of the second needle located at the

opposite side of the series of ropes from that at which the first needle entered. This second needle is then caused to penetrate the series of ropes and carry with it the thread to be again passed back by the first needle.

The next sewing-machine made its appearance at Vienna. For a record of this machine in the United States, see *Kunst und Gewerbe-Blatt* for 1817, pages 335–36. The following is a translation of a portion of the article:

"The following news is taken from No. 9 of the Royal Imperial privileged Vienna newspaper of the 12th of May of the present year (1817), about the ingenious and, in its future results, perhaps very important invention of Mr. Joseph Madersperger, in Vienna. . . . Joseph Madersperger, an ingenious native of Kuefstein, in Tyrol, and residing at present in Vienna, has already, several years ago, invented a power-machine which does all kinds of sewing work with a rapidity and accuracy far exceeding all hand-work. The approbation which his invention received everywhere has induced his Royal Imperial Majesty, in the year 1814, to give to the inventor an exclusive privilege (patent), which has already been mentioned before in these papers. Since that time Mr. Madersperger has still further perfected his invention, and his machine, that could only sew in a straight line, can now also sew crooked lines. The arrangement is completed for sewing half-circles of one inch diameter, and can, with slight changes, make small circles, egg-shaped forms, and angles of different degrees, and can also do all other kinds of sewing. The inventor has described his machine in a printed circular, and has set it up here for public exhibition. It is inclosed in a neat case, only the needle-carrier with the thread-feeder, the feed-plate with the stuff, and the crank being exposed to view. The whole machine is three feet three inches high, six inches wide, and five feet long. To keep thirteen to sixteen of these machines going, one person to change needles and lay on new stuffs and another person to set all the machines in operation with an exertion of three and one-half pounds, is quite sufficient. The inventor hopes also to simplify the whole machine still further in a short time."

In Karmarsch's *History of Technology*, page 704, occurs the following: "In Madersperger's machine the stitches were made from both sides of the stuff, and he hence had to change the form of the needle, which he pointed at both ends, forming the eye in the centre. It moved vertically up and down, piercing alternately the top and bottom of the stuff. This needle carried a thread about eighteen inches long, which had to be drawn in by the hand; and when, after about one hundred and thirty stitches, the thread was used up, the machine,

driven by a crank-handle, had to be stopped in order to replace the emptied needle by a fresh-threaded one." This Madersperger machine used the double-pointed needle of 1775, before referred to.

The records of the United States Patent Office indicate that a patent for a sewing-machine was granted on March 10, 1826, to Henry Lye, a glove-maker. The specification and model of this patent were destroyed in 1836, at a fire which consumed the records of the Patent Office. Some years since, the writer of this article devoted several days to ascertain the construction of this Lye machine, and succeeded in gaining information, from a person who had seen it, that it was simply a clamp in which gloves were held while being stitched. It was in no sense a sewing-machine, but simply a work-holder.

On May 2, 1829, an English patent, No. 5788, was granted for a "Machine for embroidering and ornamenting fabrics." It employed a double-pointed needle, or a series of needles with central eyes, which were passed through and through the material by automatically-operated pincers. The material to be embroidered was mounted upon a frame, an apparatus on the principle of a pentagraph being employed to govern the relative position of the fabric and needles, according to the pattern to be embroidered. This same class of machine, provided with clamping-jaws to hold and move the material horizontally and automatically, was made the subject of various United States patents, described as specially adapted to sew leather, among them being those of J. J. Greenough, February 21, 1842, and George H. Corliss, December 27, 1843. All these machines using double-pointed needles employed the thread in short lengths. In these machines the length of seam that could be sewn without stopping the machine depended upon the length of the needleful of thread, or the length of the clamp. Such machines are not now made.

The next sewing-machine after Saint's appeared in France. It was invented by Barthelmy Thimonnier, patented in France in 1845, and subsequently in England and the United States. This machine contained a horizontal cloth-supporting bed for the material, and a hooked needle penetrated the cloth, where it was supplied with thread from an ordinary spool by means of a rotary reciprocating looper. When the needle was raised it drew a loop of thread with it above the material and within a nipple surrounding the stem of the needle, the nipple being adapted to descend upon the cloth at stated intervals. After the loop was drawn up, the cloth was moved by hand the length of a stitch, and then the needle was again thrust through the material to receive the thread, and in its next ascent, to draw a loop through

the one previously formed and then held between the nipple and the cloth-support, the nipple and support holding the cloth firmly. The chain of the stitch was formed upon the surface of the material.

The *Scientific American* of April 17, 1869, states that in 1841 eighty Thimonnier machines, made chiefly of wood, might have been seen in Rue de Sèvres very busy upon clothing for the army, "but they were destroyed by a mob," and that in the year 1845 "the French machine was making two hundred stitches per minute." The writer has been unable to verify this statement. The needle-carrier in the Thimonnier machine was made as a sliding frame, which was depressed at each stitch by the foot of the operator and raised by a spring. Thimonnier died in 1857, penniless. The Thimonnier form of needle and thread-carrier are now used in machines for embroidering purposes and in machines for sewing leather with a waxed thread.

English patent No. 8948, May 4, 1841, shows and describes a short, needle-like, eye-pointed instrument at the end of a vibrating lever. It was used to carry a thread through the back of a glove held on a frame, the frame and glove being moved together after each stitch. The machine was designed solely for the purpose of embroidering the backs of gloves with a chain-stitch and not for sewing.

Another form of sewing-machine, now known as the running-stitch machine, made its appearance, and was patented in the United States, No. 2982, March 4, 1843, by B. W. Bean. It employed a needle with an eye at one end and a point at the other, which carried a short length of thread; the needle was held between toothed rollers, some of which corrugated the material and fed it upon the point, along the body, and off the heel of the needle upon the thread held in the eye at the heel of the needle, as in hand-needles, the operator crowding the fabric back upon the thread. This Bean machine made the running-stitch used for basting. A number of varieties of this machine were subsequently patented both in the United States and in England. They were principally used to sew together the ends of pieces of cloth to be bleached, dyed, or printed.

The patents heretofore cited illustrate substantially the state of the art of sewing by machinery up to the date of a sewing-machine invented by Walter Hunt. In Howe *vs.* Underwood (1st Fisher, *Reports of United States Circuit Courts*) it was proven that Walter Hunt invented a sewing-machine in 1833 or 1834. Justice Sprague in that case stated "that Mr. Hunt made an ingenious machine, there is no doubt; and that in many respects it was like Mr. Howe's machine, there is no doubt; that it had a needle similar to Mr. Howe's, operated by a vibrating arm and going through the cloth, a shuttle that passed

through the loop made by the needle-thread, thus making a stitch by drawing it up on to one side of the cloth somewhat like Mr. Howe's, there is no doubt. He advanced so far that he made a machine that would to a certain extent sew." The machine made by Hunt was laid aside, destroyed, and the subject was not brought up until some years after the date of Howe's patent.

Justice Sprague further stated: "The great fact of this machine having been laid aside, as it was, is not accounted for, and is entirely inconsistent with the idea that it was a perfected or valuable machine at that time. The whole testimony leaves upon my mind no doubt that, however far Mr. Hunt advanced with his machine, it was never perfected in the sense of the patent law; that it was only an experiment, and ended in an experiment, and was laid aside as an unsuccessful experiment until the introduction of Mr. Howe's machine." Hunt did not apply for a patent until some eighteen years after his invention was made, and it would never have been considered of any value whatever had not the Howe invention and patent, and subsequent improvements by others, given new life to sewing-machinery. When considering the subject of sewing-machines, Hunt should have the credit of what he invented. In Hunt's machine the material was suspended vertically between clamps moved automatically after each stitch. The machine could not be made to sew a seam longer than the clamp without being stopped, and the seam had to be substantially parallel with the parts of movement of the clamp.

Howe's machine was patented September 10, 1846. It employed two threads, one of which was projected through the cloth or material by an eye-pointed curved needle carried at the end of a vibrating arm. The needle used, and as improved by Howe, was grooved so as to receive and protect the thread from being broken during the rapid movement of the needle through the material. The point of this curved needle passed, with its thread, through the cloth about three-fourths of an inch, and left the thread, extending from the last stitch to the eye of the needle, stretched above the curved needle, something after the manner of a bow-string. A shuttle, with its point at one side, instead of at its centre, as usual, and having a bobbin provided with a second thread, was projected by an ordinary picker-staff (common to looms) through the space between the needle and thread, thereby leaving the shuttle-thread crossed over the needle-thread, so that, as the needle was withdrawn, the two threads were left locked together at the point where the needle perforated the fabric. A certain amount of thread was drawn from the spool containing the needle-thread before the needle penetrated the fabric, so as to afford sufficient slack thread

for the passage of the shuttle between the needle and its thread. A lifting-pin held up this slack thread, and prevented it from being entangled under the needle-point. The shuttle- and needle-threads were each subjected to tension at the proper times, so as to cause the shuttle-thread to appear upon one and the needle-thread upon the other side of the fabric, the crossing portions being drawn preferably within the fabric. The two thicknesses of fabric to be united were held upon pointed wires projecting laterally from a metallic plate, like the teeth of a comb, the pins holding the fabric together, thereby obviating basting, and carrying the fabric with it as the baster-plate (so called) was moved after each stitch, through the action of a pinion that engaged holes (equivalent in action to rack-teeth) made in the plate. The length of seam that could be sewed without stopping the machine depended upon the length of the baster-plate, for when the rear end of the plate reached the needle it was necessary to stop the machine, remove the cloth from the pins, return the plate to its original position, and again impale the cloth upon the pins. The cloth was suspended vertically from the pins. The outer side of the race or trough in which the shuttle was moved formed a resisting surface, or one of the holding surfaces for the cloth as it was being penetrated by the needle, and an adjustable plate outside the fabric formed a rigid presser or holding surface to retain the cloth upon the pins when the needle was drawn from the cloth.

Many persons have erroneous ideas as to the scope of the claim in the Howe patent. The broad clauses are as follows, viz.:

"A sewing-machine, constructed and operating to form a seam, substantially as described: The combination of a needle and a shuttle or equivalent, and holding surfaces, constructed and operating substantially as described. The combination of holding surfaces with a baster-plate or equivalent, constructed and operating substantially as described. A grooved and eye-pointed needle, constructed and adapted for rapid machine-sewing, substantially as described. A side-pointed shuttle, constructed and operated substantially as described."

The Howe patent was considered fully valid in the United States, notwithstanding the English patent to Fisher & Gibbons, No. 10,424, December 7, 1844, for the latter patent was not enrolled until June, 1845, which was after the completion of the Howe machine.

The Fisher & Gibbons patent was for a "Machine for working ornamental designs on lace or net and other fabrics." It was not a patent for a sewing-machine. The lace wound upon rollers was moved according to the pattern to be worked. It employed a number

of needles and shuttles, and the threads were interlocked substantially as in the Howe machine. Had it not been for the new life given by Elias Howe, Jr., to the subject of sewing-machines, the Fisher & Gibbons invention would never have been considered to be a sewing-machine, as it was not so intended, and it cannot now be so considered.

But for Howe it is fair to presume what Hunt had done would have been forgotten. That Howe's invention was original with him there is no doubt. It has never been alleged that he ever heard of the Hunt machine or that of Fisher & Gibbons. Howe's machine was capable of sewing a seam well, but it must be admitted that the machine was far from perfect. As constructed it could never have come into use as a labor-saving machine in families, for it could not well sew anything but straight seams, and such seams could not be longer than the baster-plate.

Howe had the inventor's usual hard struggle with adversity. Shortly after the issue of his American patent, Mr. Howe's brother sold one of the machines to Mr. William Thomas, of England, and Elias Howe accepted an offer from Mr. Thomas to go to England to adapt the machine to the purpose of making stays. Mr. Howe sailed for England in February, 1847, but remained only a short time in the employment of Mr. Thomas. While occupied in constructing his fourth machine he was reduced to such extremes of poverty that he sold it for five pounds, and pawned his first machine and his Letters Patent to procure sufficient money to take him to New York, where he arrived in April, 1849. In the mean time sewing-machines had come into use in the United States. Suits were commenced against infringers, his patent was sustained, and thereafter Mr. Howe reaped a golden harvest. In a petition to Congress, made in 1867, for a second extension of his patent, he admitted that he had then received $1,185,000 from the invention.

During the year 1849 one patent was issued in the United States for an improvement on the Howe machine of 1846, the improvement referring to the shuttle and means for producing tension on the thread. Four additional patents were issued during the same year for sewing-machines, two of which only need be mentioned, viz., those to John Batchelder, No. 6439, May 8, 1849, and S. C. Blodgett & J. H. Lerow, No. 6766, October 2, 1849.

The Batchelder machine employed a straight, eye-pointed, reciprocating needle, while the material was sustained upon a horizontal surface, composed of an endless belt, carried by rollers and supported centrally by a horizontal supporting surface, provided with a hole for

the passage of the needle after penetrating the cloth. The rollers over which the belt extended were moved intermittingly to move the material for a new stitch, and pins projecting from the belt, as from the Howe baster-plate, entered the cloth and carried it with the belt, thus making the feed perpetual. The cloth was held down upon this supporting surface by means of a constant but yielding pressure-roller. The stitch made was the chain-stitch. A receiving-plate lifted or detached the cloth from the pins of the feeding device. Batchelder, in this invention, was the first to combine a horizontal supporting surface for the cloth, an eye-pointed needle, and a perpetual feed by which a seam of any desired length might be sewed without stopping the machine. This patent has been twice extended, the last time by special act of Congress, and is yet in force, but will soon expire. Batchelder's invention may be stated as follows: He invented the perpetual feed. He combined a supporting-bed, adapted to support the material horizontally and provided with a throat for the passage of the needle, with a constant yielding pressure-holder; this holder, however, was a heavy roller so mounted as to rise and fall as the material was moved under it. He combined a supporting-bed, a yielding pressure-holder, a reciprocating eye-pointed needle, and a perpetual feed to move the material horizontally over the supporting-bed, under and past the needle. He combined the holding surface which supports the material immediately about the needle horizontally under the thrust of the needle, the perpetual feed which moves the material horizontally under and past the needle upon and over such holding surface, and the receiving-plate which receives the material from the feed during the operation of the machine in sewing a seam. The feed in the Batchelder machine was not adapted to permit the sewing of curved seams or turning of corners, for the pins prevented the cloth from being moved except with the feed. The receiving-plate, in function and operation, corresponds with that portion of the cloth-plate of a sewing-machine beyond the feed opening in the direction of the feed.

The Blodgett & Lerow invention was the first to impart to the eye-pointed needle the motion now commonly imparted to it in all the well-known shuttle-machines. The needle was made to descend completely through the material and then rise a little to form a loop; the shuttle then entered the loop, and the needle descended again a short distance, while the shuttle passed through the loop of needle-thread, and then the needle was raised above the cloth. This is called the dip motion.

The next invention of historical importance was that made by

Allen G. Wilson. It consisted of a rough-surfaced feeding instrument intermittingly moved to carry the cloth forward for a new stitch, after which, and while the cloth was held by the needle, it was moved backward along the under surface of the material. In a short time thereafter he devised mechanism whereby the feeding instrument was also adapted to rise and fall, it thereby being made to intermittingly grasp the cloth, move forward with it, and then release it and return to its original position preparatory to again moving the cloth for a new stitch. This second invention is used in nearly every sewing-machine now made, and is known as the four-motion feed. Mr. Wilson was the first to make this most important invention in sewing-machines. His invention, broadly stated, embraces a feeding device so constructed as to grasp and feed the material, and permit it to be turned, twisted, or directed by the operator in any desired direction between any two successive stitches; and had it not been made the sewing-machine could not have been brought to its present state of excellency and popularity as a labor-saving machine, for it could not have been adapted to sew seams of indefinite length, and of any desired curvature. The rough-surfaced wheel is but one embodiment of the Wilson invention. His first machine used a needle and shuttle, but in subsequent patents, of August 12, 1851, and June 15, 1852, he described a machine in which the shuttle previously used to carry the under thread was dispensed with, and in its place was employed a disk-bobbin and a rotating hook, shaped and moved to enter the loop of needle-thread, spread it, and pass it about the disk-bobbin containing the lower thread, leaving the latter in the loop of needle-thread. This rotating hook was a new departure from all previous ideas of sewing. Its aim was to perform by rotary motions what had been before performed by reciprocating motions, and to increase the speed and efficiency of the sewing mechanism. This hook, somewhat changed as to its outline, or construction, is used in the Wheeler & Wilson machine, both the old and new. The construction of this rotating hook, adapted to manipulate a loop of thread and pass it over the bobbin, required inventive skill of the highest type, and was perfected at great expense. In 1851, Wilson being poor and in debt, sold three-fourths of his invention to Messrs. Wheeler, Warren, & Woodruff for eight hundred dollars, and at the same time he agreed to convey, without further consideration, the same interest in all his subsequent inventions in sewing-machines.

During the summer of 1850, or while Allen B. Wilson was inventing the rotary-hook machine described in his patents, Isaac M. Singer, then residing at Boston, Massachusetts, saw a Blodgett sewing-ma-

chine in operation. In this so-called Blodgett machine, the cloth being sewn was suspended from pins projecting from a rotating hoop-like baster-plate, or pin-plate, instead of a straight baster-plate like Howe's. The needle was carried by a vibrating arm, as in the Howe machine, and a shuttle, moved in a circular race-way, carried its thread through and locked the loop of the needle-thread. Singer thought of the subject over night, and concluded that he could improve upon the Blodgett machine. The next day he explained to two others a machine such as he thought he could build. It was to contain a table to support the cloth horizontally, a reciprocating yielding presser-foot to bear upon the cloth, a vertically reciprocating straight needle, and a feed-wheel on a horizontal axis placed below the support, and pins upon the wheel were to engage and move the cloth for each stitch. This plan was to obviate the hand manipulation of the cloth as practiced in the Blodgett machine. Singer stated in an affidavit made for the extension of his first patent, that "Phelps & Zieber were satisfied that it would work. I had no money. Zieber offered forty dollars to build a model machine. Phelps offered his best endeavors to carry out my plan and make the model in his shop. If successful, we were to share equally. I worked at it day and night, sleeping but three or four hours out of the twenty-four, and eating generally but once a day, as I knew I must make it for the forty dollars or not get it at all, The machine was completed in eleven days. About nine o'clock in the evening we got the parts together and tried it; it did not sew; the workmen, exhausted with almost unremitting work, pronounced it a failure, and left me, one by one.

"Zieber held the lamp and I continued to try the machine, but anxiety and incessant work had made me nervous, and I could not get tight stitches. Sick at heart, about midnight we started for our hotel. On the way we sat down on a pile of boards, and Zieber mentioned that the loose loops of thread were on the upper side of the cloth. It flashed upon me that we had forgotten to adjust the tension on the *needle* thread. We went back, adjusted the tension, tried the machine, sewed five stitches perfectly, and the thread snapped. But that was enough. At three o'clock the next day the machine was finished. I borrowed several hundred dollars of friends to enable me to manufacture machines in Boston, giving the lenders a written agreement to furnish them with machines at a lower rate than other persons. Phelps, Zieber, and myself commenced building sewing-machines under the firm of I. M. Singer & Co. The first machine built was exactly like the one taken by me to New York, but I rapidly improved it,—made the pins shorter, and afterwards used a serrated

wheel. We began with a lot of about two dozen. Up to this time I knew of no other sewing-machine except the Blodgett. Smith & Conant, of New York, took two of my machines for two hundred and fifty dollars, and were so pleased with their operation that they offered me a garret-room for an office, and permitted me to refer to them. Zieber tried to sell machines in New York, and I traveled for the same purpose, and sold a few in Baltimore. Arrived in Philadelphia, in the spring of 1851, with three machines and fifteen dollars. I paid twelve of them for a month's office-rent. From orders that I got I was able to pay the workmen in Boston and keep the shop running. Mr. Blodgett advised me to give up manufacturing and sell territorial rights. He said he was a tailor by trade, and knew more about sewing than I could; that his had been the leading machine in the market, and he could assure me sewing-machines would never come into use. Three factories which he had established to operate with sewing-machines had failed. Discouraged by this, I started out to sell territorial rights as well as machines; all receipts were turned over to the firm. I met with continual objections from parties who had bought other machines, which they had been obliged to throw aside as worthless. In some cases I was shown to the door as soon as I had stated my business. I forwarded sketches of improvements as fast as I made them, among others that of the cut-off pad, which was so marked that I sold Essex County, Massachusetts, for two thousand dollars, and made a contract for a number of machines." The amount drawn from the company by Mr. Singer, up to November 4, 1870, was $1,956,189.74. He died in 1875, owning property valued at eight millions of dollars.

Singer, it will be observed, was not, as he thought, the inventor of the horizontal supporting surface. Saint, Thimonnier, Wilson, and Batchelder had used it before him. He used the Howe needle, but made it straight; he took the Blodgett baster-plate for a feed, but made it smaller, and placed it on a horizontally rotating shaft, and made it operate through a slot in the horizontal supporting surface, as Wilson had previously placed and used another class of feed. Shortly after making his first machine he cut the pins off from his feed-wheel and roughened its surface, as first provided for in Wilson's model in connection with his first patent. Singer, in his first machine and in subsequent inventions, contributed to the sewing-machine the following novel devices and combinations: 1st. A rotating shaft in an overhanging arm, a crank-pin or roller, and a heart-cam to operate the needle-bar positively. 2d. A presser-foot at the end of a vertical rod, held down by a spring, and adapted to yield to the thickness of

the cloth in a line at right angles to the cloth-supporting surface, and to hold the material down upon the feeding device, the under surface of the presser-foot remaining at all times parallel with the surface of the cloth-support, and in a line substantially at right angles to the line of the seam. 3d. A rotating feeding wheel projected above and through an opening in a horizontal supporting surface. 4th. A friction-pad between the seam at the cloth and the bobbin, to prevent the thread from kinking or twisting under the point of the descending needle. 5th. He gave to the shuttle an additional forward movement after it had been once stopped, to draw the stitch tight, such additional movement being given while the feed moved the cloth in the reverse direction, and the needle completed its upward motion, so that the two threads were simultaneously drawn. 6th. A spring guide upon the shuttle to control the slack of the shuttle-thread, and to keep it from being caught by the needle.

These machines first made by Singer, and employing the rough-surfaced wheel, as all but the first or second machines did, were practical machines, capable of being used successfully for sewing. Such machines were better than any before offered to the public for sewing purposes. Singer was the first to furnish the people with a successfully operating and practical sewing-machine. After the introduction of the Singer machine other inventors, with patents of earlier date, produced their machines in such form as to please the public. Singer was also the first to invent a machine for ruffling or gathering cloth, and the first to construct a device to lay an embroidering thread upon the surface of the cloth under the needle-thread.

William O. Grover and William E. Baker invented, in 1851, the machine now so well known in the market by their names. It was patented June 22, 1852. It employed a straight, eye-pointed, perforating needle, and a curved, non-perforating, eye-pointed, thread-carrying looper moving in a circular path and operating to lock, with its loops, the loops of needle-thread, making the Grover & Baker or double looped stitch. The Grover & Baker machine was subsequently somewhat changed. The perforating needle was curved and carried by a vibrating arm, and the looper or under needle was operated by the devices now common in that machine.

William H. Johnson received a patent March 7, 1854, for a sewing-machine in which the cloth was removed after each stitch by the lateral movement of the needle. This invention was made by Johnson as early as 1848. It has since been used in a number of different machines to avoid infringing the Wilson and Singer patents. It is of

great advantage in some classes of work, and is now principally used in wax-thread machines for sewing leather.

The sewing-machine is universally considered an American invention. We have seen that it was conceived in England, but to Americans belongs the credit of producing the first practical sewing-machines.

The sewing-machine was re-invented in America by Hunt forty years after Saint's date, and again re-invented and patented here by Howe fifty-six years after its conception by Saint. American inventors have worked hard and diligently to make such machines perfect in all their parts, and to adapt them to the performance of any sewing usually performed by the use of a hand-needle. American ingenuity and business energy and zeal of the highest type have been devoted to the production of the most perfect sewing-machines, and their introduction into every portion of the globe; and American machines are everywhere popular because of their superior workmanship.

Instead of having clothing manufactured by seamstresses at their own residences, as was usual prior to 1856, and from that to 1860, it is now chiefly made on machines in large factories, the machines being driven by power; and what are known as family-machines are to be found in the homes of millions of people, and in nearly every country in the world. It is estimated that 4,500,000 sewing-machines have been made in the United States. Their manufacture and sale in this country give employment to about 15,000 persons, and the capital employed is estimated to be from twenty-five to thirty millions of dollars. Three of the old established companies have sold two-thirds of this entire number of machines, and one company about one-third.

Within a few years a number of new machines have been pushed forward, and some of the older ones compelled to modify and improve their mechanical details. A sewing-machine, to operate properly with all classes of thread and of fabrics, has to be adjusted with the greatest degree of nicety, and both experience and capital are needed to place a new sewing-machine in the market, and to keep an agent in every town accessible to purchasers of the machines, so as to furnish parts or to attend to adjustments or repairs, since the users of machines and ordinary mechanics seldom know how to adjust or repair them when out of order.

As the older sewing-machine patents containing broad claims are expiring, many new machines, some not yet sufficiently matured to be put in the hands of the public, are being offered for sale. It is not perhaps generally known that it costs more to sell a sewing-machine

than it does to make it. Each well-established company employs a large force of experienced operators to teach purchasers how to use their machines, and such companies and their agents keep watch of machines sold their customers to see that they remain in proper running condition. For the manufacture of sewing-machines at a moderate cost much special machinery has to be employed, so as to avoid hand-work, and each particular part is produced by its own series of machinery. The Wheeler & Wilson, Weed, and Wilcox & Gibbs machines are made with interchangeable parts, after the system long since established in gun-making, and some of the other well-known machines are but little short of the same high standard. To manufacture the Wheeler & Wilson rotary hook, as also the Wilcox & Gibbs hook, requires several different machines, each adapted to make upon or in the hook its own particular groove or peculiar face, every curve and angle of which has been found necessary for good and rapid work.

Up to January, 1876, about two thousand one hundred and fifteen patents had been granted in the United States for sewing-machines and attachments. The inventors of sewing-machines, or the owners of patents, have availed themselves of the provision of the law for reissue in about one hundred and thirty cases. Six of these patents have been twice reissued, and three of them three times reissued. All patents issued prior to March 2, 1861, could be legally extended by the Commissioner of Patents for a further period of seven years. Twenty-six sewing-machine patents have been so extended, and one has been extended twice, the last time by special act of Congress. Out of this entire number of sewing-machine patents but few have been contested in court, and none have been declared invalid.

About four hundred and sixty of the machines represented in these patents have been adapted to make the lock- or shuttle-stitch.

The different sewing-machines represented in the United States Patent Office are capable of making upwards of sixty different kinds of stitches, using from one to three threads. The most popular of all stitches, and the one requiring the least thread, is the lock-stitch. It is made by the Howe, Singer, Wheeler & Wilson, Weed, Wilson, Domestic, Remington, Davis, St. John, Victor, Little Monitor, Florence, and other two-threaded machines wherein the spool or bobbin containing the under thread is passed through the loop of needle-thread. The most elastic and consequently the strongest stitch is the double-looped, or Grover & Baker stitch, and it requires the most thread.

The needles used in sewing-machines are either straight or curved.

The straight needle is the least liable to bend or spring when being used, and must replace the curved needle. The curved needle has to be set so that its curve and the arc in which it moves exactly coincide, otherwise it will draw the cloth, and in crossing seams it is liable to spring and break. When a vibrating needle-carrying arm is used to reciprocate the needle-bar and needle, it is necessary, in machines of different sizes, to have arms of different lengths and cams of different sizes. Such arms are vibrated on fulcrum-pins, remote from their ends, connected with the needle-bars, and if not very strongly made are apt to spring. These arms are moved chiefly either by a cam-grooved hub, a pin in the arm entering the groove in the hub, or through a heart-shaped slot at the lower end of the bar, a crank on a rotating shaft entering the slot. The rapid vibrations of this arm close to the face of the operator are considered objectionable. The grooved cam-hub is, in mechanics, considered to be a hard and slow motion, requiring much power. These cams and vibrating arms should be dispensed with, and instead of them the needle-bar should be moved by a rotating or by a rock-shaft within or behind the overhanging arm, and such shafts should operate the needle-bar through a link or a heart-cam.

In popular machines there are two ways of feeding the cloth with relation to the eye of the needle, viz.: in one form the direction of feed corresponds with the direction of the eye of the needle, and the thread passes through the eye of the needle in a direct line and with but little friction; and in the other form the eye of the needle is placed at right angles to the direction of movement of the feed, and the thread, after passing through the eye of the needle, is turned about the needle substantially at a right angle. This produces more friction upon the thread than in the other plan. The first plan is objected to by some makers because they consider that the needle has to be made a little longer than when the feed is at right angles to the eye. There is much to be said in favor of each of these plans, but the former is the preferable. One of the plans has been covered, until recently, by letters patent, and now that either plan may be used, sewing-machine-makers are free to select. The reciprocations of the shuttle should be as short as possible consistent with properly forming the stitch, and, for very rapid sewing, cranks and links are the most certain and constant in their action, and at all speeds move the shuttle just the same distance at each stroke. The best feed is the four-motioned, it being so located as to engage the material on its side next the cloth-support.

In some machines the shuttle rests in a shuttle-race, and, resting

therein, is reciprocated in contact with the race by means of a shuttle-driver, the shuttle being thereby subjected to considerable wear upon its under side. Other machines employ a preferable form of shuttle-mover called a carrier, which is shaped to receive the shuttle within it, and move with and pass the shuttle through the loop of needle-thread. In some machines the feeding device always starts from the same position for all lengths of feed and stitch, and moves forward a distance corresponding with the length of stitch. In other machines the feed always moves forward to a certain position, and retreats to a variable position depending upon the adjustment of the back-stop for the feed, which regulates the length of the stitch. In the former plan, which is preferable, the feed always engages the material at the same point, with reference to the needle, for all lengths of stitches; but in the latter the engagement is more or less remote from the needle.

The sewing-machine generally goes into the hands of persons who are completely unskilled in mechanics, and ignorant as to its principles and the method of timing its several movements to operate in unison, and it is, therefore, necessary that each machine be carefully adjusted at the factory by a skillful and experienced operator, and when adjusted, the parts should be so fixed that they cannot get out of time. A machine to be used by unskilled operators must contain as few parts as possible. Complex devices to perform some special kind of work, but seldom required by a family, should not be added to a machine for family use. Every screw or piece not actually necessary to properly manipulate the thread to form the seam, and move the fabric for each stitch, should be omitted; and in family sewing, for work other than plain stitching, attachments to be secured to the supporting-bed, or other part of the machine, should be employed. Attachments for braiding, embroidering, etc., are adapted to each popular machine.

All the sewing-machines of United States manufacture, and all foreign machines not duplicates of well-known American machines, were carefully and uniformly tested on different classes of material, thin and thick, and with the highest and heaviest threads. The white thread selected to test such machines was of the best quality, made by the Willimantic Thread Co. The finest was gauged No. 330.

Many of the exhibitors of sewing-machines exhibited elaborate specimens of work performed on their machines. The Judges of Group XXII. believing it to be the duty of the machine to produce good work, did not consider such samples of work proper subject for special award, and therefore did not recommend them for such award.

THE HOWE SEWING-MACHINE CO., *Bridgeport, Conn.*

This company is placed first in order of reference, as the patents of Elias Howe, its founder, are prior in date to those of any of the other exhibitors. The company exhibited the well-known "Howe Family Machine," also a large shuttle-machine, called the "New D. Machine," adapted to sew cloth and leather. This latter has a separable cloth-plate, so constructed as to form a flat supporting surface for ordinary work, or to leave a narrow horizontal horn, upon which may be placed a shoe-upper to be stitched or closed, or to be provided with a narrow stay-strip over the seam uniting the quarters. This stay-strip was led from a reel on the head of the machine through a guide upon the presser. This machine is built under United States letters patent to Manning, Nos. 129,974, 145,515, 152,500, 152,662, and 153,718. They also exhibited a machine of their usual kind, provided with a universal feed controlled by a pattern cylinder, and adapted to form a succession of stitches in waved or zigzag lines in any desired direction, for ornamental purposes for leather and shoe work. The feed surface was formed upon the upper end of a vertical lever, pivoted in a vertical tubular sleeve, provided at its lower end with a series of teeth engaged by a crown-wheel, having imparted to it an intermitting motion. The pawl operating the crown-wheel was vibrated constantly, but was not permitted to engage the crown-wheel except at intervals, its periods of engagement being controlled by a constantly rotating pattern-cam, made as a hollow cylinder, having rests and spaces to raise or lower the pawl. These rests upon the pattern-cam were of different widths, corresponding with the number of stitches it was desired to make in one direction. The spaces, more or less wide, permitted the pawl to engage the crown-wheel more or less times, according to the distance it was desired to rotate the crown-wheel and sleeve, to enable the axis of the freed lever, carried by the sleeve, to be placed in the proper direction to insure the movement of the feed-lever and material in the desired direction from the needle. The feed-lever was rocked upon its axis by means of a vertically reciprocating wedge-faced rod placed within the sleeve. The machine exhibited was a new one, not quite ready for the market. It was built under letters patent to Cyrus Cushman, Nos. 165,798 and 167,747. The line of stitching could if desired contain complete circles or ovals. The Howe machine is extensively used for stitching leather and shoe work. Recently it has met sharp competition in this field, the new Wheeler & Wilson and the new Weed machines having been specially designed for such work.

WHEELER & WILSON MANUFACTURING CO., *Bridgeport, Conn.*

This company exhibited their well-known rotary-hook machine with curved needle, but the principal portion of their space was used to exhibit their new No. 6 and No. 8 machines, the former for leather-stitching and manufacturing purposes and the latter for family use and light manufacturing. These new machines are destined to take the place of the old style of machine with curved needle, except, it may be, upon shirt and collar work, for which purpose the old, which may be run faster than the new machine, has no superior. In the new machines invented by Mr. James A. House, the company evidently aimed to make, regardless of cost, as perfect a machine as was possible, retaining, as the basis of the new machine, the rotary-hook and disk-bobbin peculiar to their system. The rotary-hook of the new machine—somewhat changed, however, in shape—was actuated, at a variable speed, through a slotted disk sustained in a fixed yoke placed eccentrically to the axis of the main and hook shafts. A pin on a collar at the end of the main shaft, having a uniform motion, enters one of the slots in and rotates the slotted disk connected with the hook-shaft by a pin and slot that rotates such shaft at a variable speed, the amount of variation depending upon the eccentricity of the disk and the distances of the centres of the pins from the centre of the main and hook-shafts. The take-up was operated positively by a cam-grooved hub on the main shaft, so as to draw up the loop between the time that the heel of the hook casts off an old loop and the point of the hook entered a new one, the hook then moving at its slowest speed. The take-up was operated to complete each stitch before another was commenced, and to draw up the loop when the needle was out of the cloth. The tension upon the lower or bobbin-thread was altered without stopping the machine, thus enabling the operator to readily control the stitch, and to draw the crossing portions of the thread to the centre or so as to show upon the back of the material being stitched. The No. 6 sewed leather perfectly, one hundred stitches to the inch, as did the new Weed and the Howe. The No. 6 and the Weed machine may be run faster and with less power and noise than the Howe, and they also show a higher quality of workmanship. The No. 8 differs from the No. 6 chiefly in the mechanism for controlling the needle and thread and in the size of the machine. Wheeler & Wilson also exhibited their arm-machine for sewing tubular work. All the machines of the company run quietly and rapidly. Their large manufactory at Bridgeport, Connecticut, is most complete in every detail of machinery for special work.

THE SINGER MANUFACTURING CO., *Elizabethport, N. J.*

This company, controlling the greatest amount of capital and making more machines than any other sewing-machine company in the world, not satisfied to occupy space in Machinery Hall with other United States exhibitors, built for themselves a tasteful building near the Art Gallery Annex, where they made an extensive display of their well-known family and manufacturing machines and their various other machines for special work, including machines for stitching traces, cap-front binding, covering handles for carpet-bags, glove-stitching, shoe-work, and machines for fancy stitching and working button-holes. Their exhibit included a most extensive and complete display of sewing-machine work, made at their different offices in the United States and Europe, which attracted much attention. The family machine, so extensively used, is too well known to need description, further than is set forth in the award. The machine is simple in its construction, its motions are positive, and it is always capable of performing good work, even though it has seen much hard service. The feed always returns to the same position after each feeding stroke. This machine is imitated by foreign manufacturers and approximated, as to its general outline, by United States makers more than any other machine. A great many foreign exhibits contained very good imitations of the Singer, none, however, being considered as good as the original. The Singer company now owns and exhibited the Union Button-Hole machine, well known both in this country and in Europe. It is the most perfect machine for its purpose ever made. Their machine for glove-stitching was substantially like their family machine, with the addition of a rolling presser-foot and a small additional pressing-finger, the two operating together to hold and present, in combination with the feed, one edge of a strip for a glove-finger, lapped over the edge of a second piece, both edges being so held that they were penetrated by the needle. Some of the manufacturing machines for leather-work were provided with feed-wheels. Some of their machines for tailoring are substantially such as were first made by Mr. Singer. His original machine required, in subsequent years of actual use for manufacturing, less modification than any other machine. The machine for fancy stitching was a family machine with a modified form of feed. The usual four-motioned feeding-dog, instead of being mounted in a stationary guide-way, was mounted in a grooved block, having an arm extended laterally and horizontally back toward the rear of the machine. Upon the under side of this arm were two adjustable toes. A stud extended down-

ward below the bed-plate had a ratchet collar placed upon it, to which was attached a pattern-cam, provided upon its face and periphery with adjustable pattern-pins. This ratchet, operated from the vertical shaft through a pawl, operated the pattern-cam intermittingly. The feeding device was raised and moved for the usual direct forward feed by the usual wedge-bar. A lever, operated upon by pins at the periphery of the pattern-cam, acted to prevent the return motion of the feeding devices when it was desired to move the feed laterally, the lever holding the feed forward for a certain number of stitches. The adjustable pattern-pins, extended through the face of the pattern-cylinder, were placed in two rows, the pins of one row acting upon one of the toes before referred to as being located upon the arm extended from the feed-carrying block, and those of the other row upon the other toe. These pattern-pins, acting first upon one and then upon the other toe, moved the feed laterally. If the feeding device was moved laterally and forward at the same time, the result was a diagonal feed. These pins, so arranged upon the rotating hub as to indicate its pattern, compelled the movement of the feed in a particular direction from the needle-hole for a determined number of stitches. These changes in the direction of the feed resulted in the production of an irregular, zigzag, angular, or waved line of stitching, which presented an ornamental appearance. Lines of stitching of practically unlimited variety could be produced upon this machine, but all the curves were necessarily made in a forward direction, as the result of a forward and diagonal movement. The feed not being universal, a lateral and backward movement could not be combined to complete a curve or oval, one-half of which was produced as the result of a forward and diagonal movement. This fancy-stitching machine is manufactured under patents Nos. 151,801, 150,492, 141,088, 130,324, 130,325, 126,844, 126,845, and 122,673. The Singer Manufacturing Co., besides their extensive works at Elizabethport, have a large factory at Glasgow, Scotland.

WEED SEWING-MACHINE CO., *Hartford, Conn.*

This company exhibited its well-known Family Favorite shuttle-machine, their "G. F.," a manufacturing machine, and a new shuttle-machine, a most creditable production of Mr. G. A. Fairfield. The latter was of the best workmanship and materials, and was made on the interchangeable plan, most of the parts being formed by a system of drop forging. It was simple, comparatively silent when being operated, and performed most creditable work upon cloth and leather. The shuttle and needle movements were derived from cranks and

links, and were consequently positive. The feeding device was moved positively in all directions, and was controlled, as to the extent of movement, by a screw above the cloth-support. The bearings for the main and other shafts, and the shuttle-carrier slide (V-shaped in cross section), and the straps of the eccentrics were all made to compensate for wear of the parts. The needle-bar and needle and shuttle co-operated to draw up and complete each stitch independently. In stitching leather, one purpose for which the new machine is especially adapted, some operators at times desire to employ a needle common to some other machine, and to permit this change the needle-shank was held in a nipple-like holder, confined by a screw at the lower end of the needle-bar. These holders are each provided with an opening of proper shape for some particular needle, and a number of them may accompany one machine. The threads were drawn, with relation to each other, substantially as in the Howe.

THE WILSON SEWING-MACHINE CO., *Chicago, Ill.*

This company exhibited its shuttle-machine. The needle-bar was reciprocated by a vibrating arm or elbow-lever, provided at its lower end below the cloth-support with a heart-shaped cam-slot, into which projected a crank-pin, at the end of a short horizontal main shaft, at right angles to the overhanging arm. A short arm, carried by this shaft, was connected by a link with a shuttle-driver that acted to propel the shuttle in the race-way parallel with the overhanging arm, and at right angles to the direction of movement of the four-motioned feed. An eccentric on the main shaft actuated a slide-bar provided with inclines to impart to the feeding device its upward and forward motions, a spring which caused it to descend and return to the variable back-stop determining the length of stitch.

THE DOMESTIC SEWING-MACHINE CO., *New York, N. Y.*

This company exhibited the machine known as the "Domestic," as well as one constructed after the same general plan for leather stitching; and before the close of the Exhibition they included within their exhibit the Grover & Baker machine. The "Domestic" employs a straight needle and shuttle, and makes the lock-stitch. The main rotary shaft having a large balance-wheel, and being mounted in the overhanging arm, is provided with a crank-pin to enter a heart-cam upon and to reciprocate the needle-bar, giving it the usual dip motion. The shuttle is moved by a carrier at the end of a horizontally vibrating arm, having its short end forked to receive a ball attached to the lower end of a vertical lever, bifurcated at its upper end to embrace an eccen-

tric on the main shaft, the eccentric vibrating the vertical lever, and it, in turn, vibrating the shuttle-carrying lever. The usual four-motioned feeding-bar derives its up-and-down motion from a push-rod connected with the vibrating shuttle-moving arm, and its forward movement from an angular lever, connected with a feed-lever, operated by a vertically reciprocating feed-connecting rod, and lowered by an eccentric on the main shaft. The end of the feeding lever is provided with an adjustable screw, which may be caused to extend a greater or less distance below it, so as to be engaged sooner or later by the feed-connecting rod to lengthen or shorten the stitch. The feeding lever and feed are moved in one direction by a spiral spring. The angular lever engages the end of the pushing-rod after it is projected through the feed-bar. The machine intended to sew leather had a wheel-feed and a rolling presser, and a device at the top of the head to control the needle-thread.

The Grover & Baker machine is too well known to need description, further than to say that the stitch made by it is formed from two threads taken directly from two spools. One thread is carried by a curved perforating needle at the end of a vibrating arm, and the other (the under thread) is carried by a rotary reciprocating eye-pointed looper at the top of a vertically placed rotary reciprocating shaft. For bag work the stitch made by this machine has no equal. Silk being used below, it is also excellent for embroidering purposes.

THE REMINGTON SEWING-MACHINE CO., *Ilion, N. Y.*

In the Remington shuttle-machine the straight needle and needle-bar were operated by a heart-cam. The main upper shaft was provided with an eccentric, connected by a link with an arm upon a rock-shaft below the cloth-support, it having at its forward end a crank connected by a link with a shuttle carrier. The shuttle was moved parallel with the feed. A second eccentric on the main rotating shaft operated a link connected with a second link placed in a horizontal position, and attached to the arm of a rock-shaft provided at its other end with an arm, connected with and adapted to reciprocate the four-motioned feed-slide or bar horizontally. A cam at the end of the shuttle-moving shaft struck one end of a two-armed sleeve, placed loosely upon the rocking shaft of the feed-mover, and the other arm, provided with an adjustable screw, acted upon an adjustable shoe or block on which the feed-slide was supported, and lifted the feed, a spring moving the feed back and down. The thread-controlling lever was placed on a short stud extending through the face-plate, and within the head of the machine it was provided with a V-shaped fork,

each member of which was so placed as to be acted upon by one of two cam-surfaces formed on the periphery of the disk that carried the needle-bar-moving crank-pin. A spring pressed the upper member of the form constantly toward its cam. This thread-controller was free to yield to the strain of the thread upon it, except at such times as the lower member of the V-shaped fork was acted upon by its cam-wheel, which was the case just as the needle tightened the stitch. This take-up is fully described in patent No. 164,179.

The Remington Co. also exhibited an ingenious button hole machine, made under United States patents to S. Cleminshaw, Nos. 110,739, 128,363, and 139,770. This machine employed a single thread, contained in a shuttle held in a recess at the lower end of a vertically reciprocating bar, the shuttle having at its lower end an eye-pointed perforating needle. The shuttle-thread was led through the eye of the needle. The needle penetrated the material just back of the edge of the button-hole slit, a loop was formed in its thread, the loop was drawn out, and a thread-catcher drew this loop up through the button-hole slit and passed it over the upper end of the shuttle. The block and needle were then lifted through this loop. In this way the shuttle was caused to pass through a loop made in its own thread. The piece of fabric provided with the slit for the button-hole was passed over a finger-like post, where it was confined by a pair of jaws while the edges were being stitched. This machine appeared to be adapted to work a very good button-hole in cotton goods or linen, a difficulty heretofore experienced in other button-hole machines.

The Remington Co. also exhibited a button-hole attachment adapted to be applied to the head of the machine, and made under patents Nos. 94,212, 103,745, and 146,000. The attachment was composed of a looper, placed at an angle to the movement of the usual needle adapted to penetrate the fabric back from the edge to be worked. This looper had an eye at its lower end, and passing through the button-hole slit in its descent, placed its eye below the cloth-support and fabric, in the path of movement of the descending needle, where it rested until the needle penetrated the fabric and entered the hole in the looper. The shuttle then passed through the loop of needle-thread, and the needle was raised, drawing the shuttle-thread up with it through the eye of the looper, when the looper was drawn up, bringing the shuttle-thread; when this loop of shuttle-thread was drawn above the edge of the fabric, a finger engaged and carried it back over the edge, upon the upper side of the material, where it was entered by the needle in its next descent. The needle entered the hole in the looper at each descent.

THE ST. JOHN SEWING-MACHINE CO., *Springfield, O.*

This company exhibited a shuttle-machine employing a straight needle and a vibrating shuttle to make the lock-stitch. The main driving-shaft, placed in the overhanging arm, had at its forward end a disk with a pin provided with a swiveling-block to enter a horizontal groove or way in an adjustable cross-head attached to the needle-bar. The needle-bar was moved down and up without the dip-motion common to most, if not all, well-known shuttle-machines. A crank on the main shaft was connected with a lever of the first order, provided at the lower end with a fork to embrace an adjustable ball-like termination of the shuttle-carrying lever, pivoted on a stud attached to the under side of the cloth-support. This shuttle-lever was vibrated horizontally by the vertical lever. Small disks, concaved on one side and flat on the other, were interposed between the ball-like and lower end of the vertical lever, to receive the wear and make the movement steady. The four-motioned feeding surface was operated by a wedge-bar, connected with the shuttle-carrying lever, the fulcrum of the lever being movable, through a sliding-bar, to vary the length of stitch. The machine was made to sew whichever way the main shaft was rotated. The time of the feed-movement with relation to the movement of the needle was not just the same when the shaft was moved in one direction as it was when the shaft was moved in the opposite direction. The machine will probably be driven for the most part in one direction, but should it be moved in the other direction, in starting, it will sew. By a simple attachment at the end of the main shaft, the fly-wheel was released from the main shaft when it was desired to wind bobbins. The take-up lever, pivoted at one end and provided at the other with an eye, was operated by a pin, connected with the lever between its free end and fulcrum, the pin and take-up deriving their upward movement from a cam on the main shaft. The take-up was depressed by the needle-bar in its downward movement, and commenced to draw the thread just before the shuttle passed through the loop of needle-thread. The wearing parts were made adjustable. The machine was very well made.

THE VICTOR SEWING-MACHINE CO., *Middletown, Conn.*

This company exhibited a lock-stitch shuttle-machine. The straight needle and needle-bar were moved by a vibrating arm actuated by a grooved cam-hub on the main rotating shaft. A pin on the needle-bar entered a slot in the take-up lever and operated it. A link, moved

by an eccentric, was connected with an arm of a rock-shaft having at its other end a second arm to which was adjustably connected a link that operated the feeding device. The shuttle was driven in a race, by means of a crank and link on the main shaft, these operating the shuttle-driver.

THE WHITNEY MANUFACTURING CO., *Paterson, N. J.*

The machine exhibited by this company was designed to make the lock-stitch by means of a straight needle and a reciprocating shuttle. The needle bar was reciprocated by means of a vibrating arm operated from a grooved cam-hub on the lower main shaft. A crank connected with this shaft, through a link, reciprocated the shuttle-driver to impel the shuttle in the race. The crank-arm was made double, to operate a short shaft provided with a crank-pin to enter a slot in and vibrate a lever provided at its upper end with an inclined slot to embrace a pin on the feeding-bar and move it positively. The take-up lever was operated by the needle-bar. The tension device for the upper thread was a screw-like cylinder about which the thread was wrapped. In general appearance and operation the machine resembled the older form of machine made by the Weed Sewing-Machine Co.

THE FLORENCE SEWING-MACHINE CO., *Florence, Mass.*

The machines exhibited by this company made the lock-stitch. Their family machine is well known. It employed a curved needle, carried at the forward end of a vibrating arm, operated from a horizontal shaft across the end of the machine. The shaft had a link connected with it that operated the shuttle-driver to move the shuttle in the race, the latter being arranged in a plane parallel with that in which the needle-carrying arm vibrated. A vibrating arm below the cloth-plate took up the slack of the shuttle-thread as the shuttle was moved backward. The feeding device had the usual four motions. A pivoted, grooved block, connected with the feed, was arranged to be more or less inclined either way from a vertical position, to govern the distance of the feeding movement in a forward or reverse direction; or by it the feed could be stopped while the needle descended twice at the same spot to tie a knot. A cam on the main shaft acted to take up the thread. The machine is more adapted for light family sewing than for heavy work. A manufacturing machine, built by this company for manufacturing purposes, employed a straight needle, carried by a needle-bar, operated by a trammel motion, having its centre placed eccentrically to the shaft that carried the disk in which were made the crossing grooves that received the trammel-

slides. The link of the trammel connected with the needle gave to the needle-bar the dip motion. The take-up was operated by a cam on the main shaft, located in the overhanging arm. A machine substantially like the one last referred to was exhibited by the Wanzer Sewing Machine Co., of Canada. The Canada machine was considered the more perfect as to details of construction, finish, etc.

J. & W. Lyall, *New York, N. Y.*

This firm exhibited the "Whitehall" machine. The mechanism below the cloth-plate was substantially like that in the Singer Family Machine, with the exception that the feed-operating lever was moved by an eccentric, rather than by a double cam. The main rotating shaft in the overhanging arm was provided with a gear engaged by a gear upon the upper end of a vertical shaft, as in the Singer. Instead of the heart-cam used in the Singer, the forward end of the main shaft had, attached to it, an annular disk provided with a toothed gear, having a crank-pin connected by a link with a pin upon the needle-bar. A stationary tubular sleeve surrounding the end of the main shaft was provided with a pinion, and the teeth of the pinion, carried by the disk, engaged the teeth of this stationary pinion as the disk revolved, thereby revolving the crank-pin, as the pinion carried by it was rotated in a circular orbit about the axis of the main shaft. This epicycloidal motion gave to the needle the same motion as the heart-cam. This machine had not the speed of the Wilcox & Gibbs, but was capable of being run faster than any other shuttle-machine. It will be found described in patents Nos. 134,119, 166,172, and 184,938.

Cole's Universal Feed Sewing-Machine Co., *New York, N. Y.*

The machine exhibited by this company made a lock-stitch, and employed a straight needle and reciprocating shuttle. The vibrating needle-bar was operated by a vibrating arm and a cam-grooved hub. A crank at the extreme forward end of the shaft was connected by a link with the shuttle-carrying slide. The rough-surfaced four-motioned feed was made as an annulus, and projected from a jointed portion of a pivoted sliding-bar, carrying at its back end a circular disk provided with a quadrangular opening to receive an oblique-faced cam, adapted to be moved up and down within the opening in the disk. The cam was arranged to slide upon a square shaft attached to the under side of the cloth-plate, but capable of being rotated by means of a crank, under control of the operator, so as to place the acting faces of the oblique cam in the desired direction. The disk

turned with the shaft and cam as they were turned, and by changing the position of the shaft and cam, the sliding-bar and feed could be moved in any desired direction toward or from the needle in a radial line. The feed was universal as to its direction of movement. For embroidering large garments or pieces of cloth when it was desired not to turn the goods upon the cloth-support, this machine was provided, about the needle-head, with an annular toothed plate, supporting a presser-foot, braid-holding spools, and tension devices. A toothed wheel, on the square shaft before referred to, was connected by bevel gears and vertical and horizontal shafts with the toothed wheel carrying the braid-spools, and in this way, as the direction of the feed was changed, the position of the braid-holding spools and presser was also changed to operate in unison with the feed and needle, and permit the braid to be seen upon the surface of the material. For the purpose of braiding fabrics in fancy design, the braid being stitched by a lock-stitch, this machine was very efficient. It is fully described in United States patent No. 134,463. The machine was rendered unnecessarily complicated for the purposes of family sewing because of the complex character of the feed-mechanism.

AMERICAN BUTTON-HOLE OVERSEAMING AND SEWING-MACHINE CO., *Philadelphia, Pa.*

This company exhibited several different machines, among them a combined sewing- and button-hole-stitching machine. It was adapted to be used as an ordinary sewing-machine, and, by a slight alteration, could be converted into a button-hole-stitching machine for family use. The needle-bar was reciprocated by a vibrating arm moved as usual. An eccentric near the forward end of the shaft operated the feeding device, it being a vertical bar serrated at top and moved in an elliptical path. Another eccentric through an arm vibrated a vertical arm pivoted at its lower, and provided at its upper end with shuttle-driving horns to drive a shuttle upon a curved race-way, also pivoted and adapted to be moved into or out of working position. The connection between the eccentric strap and shuttle-driving arm was disconnectable, to permit the shuttle-race and mover to be turned away when it was desired to work button-holes. When the shuttle-race was in position the machine was set for plain sewing. To prepare for button-hole work it was necessary to turn the race and shuttle-driver down, and engage the end of a vibrating looper-lever with a cam to operate it. This looper provided with a thread was adapted to be moved to pass its thread up through the button-hole slit. A sleeve-like loop-taker surrounding the needle-bar, and provided at its lower

end with a notch, was then lowered into operative position, so that the loop-taker could seize the loop of looper thread, carry it back from the edge above the upper side of the cloth, and hold it open for the passage of the eye-pointed perforating needle in its next descent. All the changes necessary to be made to fully describe the operation of changing from plain sewing to button-hole stitching, and *vice versa*, need not necessarily be described here. The button-hole devices work best upon heavy or woolen fabrics. Button-holes in linen and white cotton goods can be best worked by hand.

This company showed a machine with the button-hole features removed, and designed to make only the lock-stitch. It also exhibited a machine containing the button-hole features, and designed specially to sew carpets with an overedge-stitch. In such machine the carpet was stretched upon a long table, and the machine and the operator's seat were made to travel along the table, the machine uniting the edges of the carpet. This machine was the only one of its kind on exhibition in the American department. It is effective for the purpose intended, and operated well. A finger extending between the two edges of the carpet to be sewed pushed back the pile loops. The finger was not used when sewing ingrain carpets.

They also exhibited a novel and special machine to bind and cord the edges of woolen and other blankets to be dyed, wherein it was desired to protect the edges of the blanket so that they could not be dyed, but would remain white. This machine used a single thread. A tubular guide delivered a small rope within the turned-over or rolled edge of the blanket, turned or rolled by means of a scroll. A strip of heavy cotton binding was automatically applied over the turned blanket edge and rope, and was sewed down about the blanket edge and rope by a single thread extended about all, as at the edge of a button-hole or in overseaming.

No other company showed a machine for this purpose.

JOHNSON, CLARK, & CO., *Boston, Mass.*

This company exhibited the Home Shuttle-Machine. It was adapted for hand use, made a lock-stitch, and employed a straight needle and vibrating shuttle. The needle-bar was moved by a heart-cam on the upper rotating shaft. The lower rotating shaft was provided at its forward end with two cams, one to lift and the other to move the four-motioned feeding device forward, a spring returning it. The shuttle was carried by a centrally pivoted vibrating lever, provided at its back end with an adjustable fork to embrace an eccentric upon the lower shaft, the eccentric moving the shuttle-lever. A lever,

controlled as to its position by a thumb-screw above the table, determined the backward position of the feeding device. This company showed some of the same machines mounted on tables connected with treadles, and one or two other forms of shuttle-machines not differing essentially from the one described.

THE GOODES ORNAMENTAL, PLAIN, AND OVERSEAMING LOCK-STITCH SEWING-MACHINE, *Philadelphia, Pa.*

The machine exhibited by this company was made under United States letters patent No. 136,718. It was a shuttle-machine in which the vibrating needle and shuttle actuating arms were moved by grooved cam-hubs as usual. The needle-bar carried two perforating needles. A sleeve and pin applied to the needle-bar, and to the head of the machine, acted to rotate the needle-bar once around at one complete ascent and descent, and at the next ascent and descent of the needle-bar it was rotated once around in the opposite direction. When the needles penetrated the cloth they were in proper position for their loops to be entered by the transverse moving shuttle. By the rotation of the needle-bar in this way the threads carried by the two needles were crossed upon the surface of the fabric, and extended alternately from one to the other line of seam diagonally. To make the stitch more ornamental a toothed sleeve, having teeth of varying length and made longitudinally movable upon the end, was applied to the main shaft, where it was adjustably fastened by a screw. The feeding-bar, having a roughened surface, was made movable on its carrier, which was moved by a cam which imparted to the bar its usual four motions. A crown-wheel attached to the under side of the cloth-support had, at its upper end, a cam adapted to operate a link and move a forked feeding-bar guide, so as to place it in a position inclined to one or the other side of the path of movement of the feeding-bar, and cause the latter to be moved laterally toward the right or left as it was moved forward, a pin on the feeding-bar entering the slot in the guide, thereby moving the fabric diagonally in any direction. The angle of inclination of this guide governed the extent of the lateral throw of the feed. The crown-wheel was moved so as to cause this cam to operate the guide its full distance at each rotation of the main shaft, or only part of its distance at each rotation. The sleeve, when moved fully back on the shaft toward the rear of the machine, occupied such relation with reference to the crown-wheel, that all the teeth of the sleeve operated upon it, rotating it half a rotation; and the stitching was made in zigzag lines, each diagonal stitch being one stitch in

length. If the sleeve was moved forward toward the end of this shaft, so that but one tooth of the sleeve engaged the crown-wheel, then the latter with its cam was arranged to move the feeding-bar gradually in a lateral direction at each stitch, and the diagonal portion of the stitching was then composed each of several stitches. If the sleeve was fully drawn forward till its teeth were out of position the crown-wheel was not operated, and the feed was in a direct line. The number of stitches in any one angular direction depended upon the number of rotations of the cam-shaft necessary to semi-rotate the crown-wheel and cam, and this might occupy a greater or less number of rotations of the shaft according to the position of the toothed sleeve and the number of its teeth in operation with the crown-wheel. The machine, when the lateral feed and rotating needle-bar co-operated, made quite a variety of ornamental lines of stitches, composed of angular or zigzag stitches, with two threads of the same or different colors crossed. If the rotary motion of the needle-bar was thrown out of operation, the two contiguous rows of stitches were still made in irregular or angular lines but were not crossed, and if both the rotary motion of the needle-bar and the lateral motion of the feed were discontinued, then the machine stitched simply two parallel seams. One needle might be omitted for plain sewing. The varieties of stitches made by the crossed threads and lateral feed were different in appearance from the ornamental stitching done by any other usual machine, and the threads being of different colors added to the ornamental effect of the stitches.

THE DAVIS SEWING-MACHINE CO., *Watertown, N. Y.*

This company exhibited the machine known as the "Davis Vertical Feed" Sewing-Machine. It employed a vibrating shuttle and straight needle, and made the lock-stitch. The shuttle was carried by a horizontally vibrating shuttle-carrying lever, operated from a vertically vibrating lever pivoted at its upper end, and provided with an opening to receive an eccentric on the hub of the fly-wheel. The ball-like lower end of the lever entered a fork at the back end of the shuttle-lever. An adjustable saddle placed in the opening of the vertical lever compensated for the wear of the lever and eccentric. A crank-pin, on a disk at the end of the rotating shaft in the overhanging arm, entered a heart-cam on a slide-bar that carried the needle-bar and reciprocated it. The slide-bar to which the heart-cam was attached had at its opposite or outer side a swiveling stud on which the needle-bar was placed. At the right-hand side of the needle-bar (looking at the machine from the front of the head) there was a needle-bar vibrator,

pivoted at top and adapted to be moved laterally or vibrated at its lower end by means of a stitch-regulating lever having an adjustable fulcrum. The lower end of this stitch-lever was connected directly with the needle-bar vibrator, and as the stitch-lever was vibrated by the cam-shaped disk at the forward end of the main shaft, the vibrator moved the needle-bar laterally to feed the material. The presser-foot was held down by a spring, and lifted by a slotted lever having its fulcrum on the helper-bar, a friction-roller on the needle-bar entering a slot in the lever and lifting it at every down stroke of the needle-bar. A helper placed between the needle and presser bore upon the material when the needle was in the fabric, and as the needle moved laterally in the fabric the helper also moved laterally with it, and the needle and helper co-operated together to feed the material for each stitch. Were it not for the helper moving with and in advance of the needle, the material would be strained and liable to be bunched or drawn by reason of the strain of the needle upon the goods. A slotted and vibrating take-up and thread-controlling lever was operated by means of a friction-roller on the needle bar. The shuttle was reciprocated upon a race by a driver. This class of feed has its advantages for some special work; no other family machine has a feed of this kind.

McLean & Bennor Machine Co., *Philadelphia, Pa.*

This company exhibited two machines. One, the "Philadelphia Sewing-Machine," is substantially like the machine represented in United States patent No. 101,292. The shuttle was held in an inclined position in a stationary shuttle-holder below the cloth-support and in line with the needle. A rotating hook operated by a crank at the end of the main shaft caught the loop of needle-thread, distended and passed it about the shuttle, forming a lock-stitch. The machine was provided with a reciprocating-rod or finger to twist and detain the loop of needle-thread, cast off from the heel of the shuttle, until the needle in its next descent passed through it. This enables the machine to make a twisted chain-stitch with a locking-thread. By omitting the shuttle-thread and permitting the finger and hook to operate, a chain-stitch may be produced.

They also exhibited a cheap needle-feed sewing-machine, having under the cloth-support a vibrating thread-carrying looper, that, co-operating with the needle, acted to form a two-threaded double-looped stitch. The machine was made in accordance with United States patent No. 105,961.

WARDWELL MANUFACTURING CO., *St. Louis, Mo.*

This company exhibited the Wardwell machine, using an eye-pointed, straight, perforating needle and a spool-case in which was placed a common spool containing thread. A crank on the main rotating shaft was connected by a link with the vibrating needle-actuating lever that received the ball-like upper end of the needle-bar. The needle, made specially for this machine, had a ball-like head, and was held between prongs at the lower end of the needle-bar, the construction of the prongs being such as to permit the needle to be inserted and held in the needle-bar without screws. A cup-shaped hook at the end of the main shaft was arranged to catch the needle-thread, and spread and pass its loop about a case containing a spool of thread. A take-up drew back the long loop of thread through the eye of the needle. The feeding device had four motions, and the devices for moving it were inclosed in the cloth-plate. The machine was mounted upon a circular table which could be rotated upon the machine-stand. The driving-wheel, crank, etc., were connected with the turning-stand, and the pitman was connected by a ball-joint with the treadle, and in this way the machine was arranged to be freely turned upon the table, thereby permitting the feed to move the cloth in any desired direction with relation to the operator. A general idea of the machine may be obtained from United States patent No. 128,684. The machine was not thoroughly completed nor ready for the market.

G. F. DA LANEY & CO., *New York, N. Y.*

This firm exhibited the machine known as the "Little Monitor." It made the shuttle-stitch, or a chain-stitch with an interlocking thread, directly from two ordinary spools, or by omitting the under thread it would make a chain-stitch. The machine ran very lightly, made little if any noise, was well adapted for light family work, and is the most practical embodiment yet made of a machine to form the lock-stitch from two ordinary spools. The under spool was contained within a hard rubber spool-case held between two concaved metallic holders by a pivoted stop. The shank of the hook was pivoted upon a crank, a pin at the lower end of the shank of the hook entering a slot in the hanger. After the needle was elevated a little to form the slack in its loop, the hook caught the loop and pulled it over the point of the spool-case, which passing over, it slipped from the hook. This loop, inclosing the spool-case thread, was left loose on the top of the spool-case, until the hook in its rotation took a new loop of needle-thread, and in its continued movement drew taut the loop and

completed the stitch. The tension device was composed of a grooved metal disk, attached to the overhanging arm by a screw, which served as its axis. The thread was wound once around the tension-wheel, and the wheel, grooved on its inner side to receive the wedge-shaped end of a vibrating clutch-bar, was moved at each stitch the distance necessary to deliver enough thread for a stitch. The long bight of thread necessary to pass about the bobbin was kept under the cloth to be operated upon by the hook, and was not drawn backwards and forwards through the needle-eye, as usual in this class of machines, the friction upon the thread consequently being greatly diminished. The presser-foot, placed in position by thick or thin material, was caused to act upon the tension-wheel actuating-clutch, to vary the length of thread delivered for fabrics of different thickness.

THE WILCOX & GIBBS SEWING-MACHINE CO., *New York, N. Y.*

This company exhibited their new machine with automatic tension, adapted to operate, without change, on the finest and coarsest threads with which this machine is ever used in family sewing. The rotating shaft had, attached at its forward end, a small hook that engaged the loop of needle-thread, and held it spread open until the needle in its next descent entered the loop held by the hook, which entered the new and discharged the old loop. The construction of this hook required great inventive skill and many special machines and tools to give it its exact and necessary shape. The stitch is known as the single thread or chain-stitch. The needle-bar actuating lever derived its movement from an eccentric on the hub of the fly-wheel. The stitch-regulator, that determined the extent of reciprocation of the four-motioned feeding device, was provided about its periphery with figures arranged to be shown through a slot in the cloth-plate, such figures indicating the number of stitches to the inch, with the stitch-regulator in that position. The spool of thread was supported upon an inclined spool-spindle, the head of the spool resting against a concaved disk, about which the thread was drawn without rotating the spool. The thread from the spool passed through an eye in the vibrating lever, and was so acted upon by pins between the lever and overhanging arm as to draw off at each stitch the amount of thread needed for the next stitch. When the thread was drawn or pulled for this purpose, it was held nipped between the faces of the automatic tension device, and could be drawn only from the spool. The thread, after leaving the vibrating arm, passed to the tension device. An eye at the upper end of the needle-bar, and a rest located near it, controlled the slack of the thread when the needle descended, and

held it until the point of the needle entered the fabric. A scale on the cloth-plate indicated the size of needle and length of stitch that should be used with any given size of thread, leaving the operator to decide only what sized thread was proper for any given material, and the machine, set in accordance with the direction of the index, enabled the operator to produce the best and most uniform stitching. This index was only the judgment of the best operators tabulated. The moving parts of the machine were interchangeable, and of very superior workmanship; and the machine is the easiest, fastest, and most quiet-running machine ever made. The new machine is fully described in United States patents Nos. 116,521, 116,522, 116,523, and 116,783.

CHARLES E. WILLIS, *New York, N. Y.*

This exhibit consisted of a Wilcox & Gibbs sewing-machine with a feed attachment to perform zigzag or waved-line stitching. The feed was said to be universal, but it could not be used in all directions with the machine to which it was applied, because the rotating hook would fail to take the loop of needle-thread when the feed moved in some directions.

G. C. WALTERS, *Philadelphia, Pa.*

A sewing-machine to sew green hides, United States patent No. 137,640. This machine employed a hooked needle and cast-off above and a thread-guide below the material. The material was intermittingly clamped between two rough-surfaced plates slotted for the passage of the needle and adapted to engage the material on both sides and move with it at each stitch. The machine was strongly made, and adapted only for this class of work.

G. W. BAKER, *Wilmington, Del.*

A sewing-machine adapted to the special work of sewing green or wet hides. It employed a hooked needle and cast-off, and made the chain-stitch. The head of the machine in which the needle reciprocated was vibrated at the proper time, and the needle then acted as the feeding device. The lower end of the needle was held and steadied by a laterally movable throat when the feed operated.

WILLIAM PEARSON, *Philadelphia, Pa.*

A sewing-machine to unite the loops at the edges of knitted fabrics, with a single thread, over-and-over stitch. The loops were set up, or looped upon stitch-hooks projecting horizontally from a horizontally moving plate, moved after each stitch by a suitable gear. United States patent No. 166,805.

UNITED STATES SEWING MACHINE CO., *New York, N. Y.*

A chain-stitch sewing-machine, useful only as a toy. Price, five dollars.

The above-cited exhibits were in condition to be, and were examined by the Judges of Group XXII. Other exhibitors of sewing-machines mentioned in the Official Catalogue had not their machines unlocked or exposed for exhibition until after the completion of the examinations and awards.

THE EICKEMEYER HAT-BLOCKING MACHINE CO., *Yonkers, N. Y.*

This company exhibited a machine for sewing sweat-linings in hats. The machine had an acute-angled supporting-plate to sustain the hat in which the leather or other sweat-lining was to be stitched, the brim of the hat, either soft or stiff, and flat or curled, projecting downward over the edge of the support. The machine was pivoted upon its table, and the supporting-plate was divided into two parts to provide for the adjustment of the supporting-plate and machine to balance the hat, and support the crown properly according to its shape. The feeding device engaged the outside of the hat at the junction of the crown and brim. The stitching mechanism, an eye-pointed needle and a looper, co-operated together to form a chain-stitch. The presser-foot was provided with interchangeable guides, one of which was adapted to guide the edge of the sweat-lining right side up, so that the needle might descend through the extreme lower edge of the sweat-lining, and then through the hat, forming the loop of the chain-stitch on the outside of the hat, such loop being subsequently covered by the hat-band. The other guide was used with hats of better quality. It presented the edge of the sweat-lining wrong side up to the action of the needle, and after the formation of the seam the sweat-lining was turned into the hat, concealing the stitches and preventing the passage of perspiration along the stitches to the outside of the hat. When hats are provided with a sweat-lining in this last-mentioned way, the edge of the lining is first turned over and creased by a sweat rolling-machine.

KIMBALL & MORTON, *Glasgow, Scotland.*

This firm exhibited several varieties of two-threaded, shuttle, and chain-stitch machines made by other persons, and not therefore subject to award. Among their machines were well-made copies of the Singer machine. A large machine designed specially to sew bagging, sails, etc., was found to possess merit. This machine was

substantially the Singer in all particulars, except that the head in which the needle-bar and presser were moved was adapted to be moved laterally, first in one direction and then in the other, at each ascent of the needle, to make a herring-bone stitch, and that it had a top-feed. To move the head laterally a grooved switch-cam on the main shaft vibrated a vertical lever connected adjustably with a link that operated the head. A table or sail-support, mounted upon a track or way, was automatically moved in front of the machine to feed and present the sail to the action of the needle. Another Singer form of machine had a novel thread-carrying looper pivoted upon the shuttle-carrier slide for overseaming purposes. It passed its thread through the loop of the needle-thread and then presented its own loop above the edge of the fabric for the passage of the needle through it and the fabric at its next descent. The machines exhibited by them were superior to those of other British exhibitors.

NEWTON, WILSON, & CO., *London, England.*

This company exhibited several different kinds of hand-operated shuttle-machines, adapted to be also run by belt if desired. Among them were those denominated "Queen ó' Scots," "Princess of Wales," "England's Queen." They also exhibited copies of Singer, and Wilcox & Gibbs machines with hand-attachment, and Wheeler & Wilson machines. The two machines first mentioned were submitted for examination. Each had straight needles operated by heart-cams. The upper and lower parallel rotating shafts were driven by an intermediate gear. In one of these machines the shuttle-driver slide was provided with slots crossing each other at right angles; the lower shaft extended through the slots, and a pivoted block on the shaft, entering the slot, moved the driver and shuttle. The presser-foot lifting lever was so arranged that it might be turned upward in position to be struck by a rotating cam in the head of the machine, lifting the presser at each stitch. The feed was the usual four-motioned.

In the machine called "England's Queen" a crossing grooved cam or switch-cam was placed at the end of the lower shaft, and a swiveling-toe, connected with the feed, was arranged to be operated by it to impart to the feed lateral motions for zigzag stitching.

The Singer machines had added to them a lifting presser-foot lever operated by the needle-bar.

C. W. WILLIAMS MANUFACTURING CO., *Montreal, Canada.*

This company exhibited only copies of Singer machines. Their workmanship was good.

J. D. LAWLER, *Montreal, Canada.*

An exhibit of copies of the Howe machine wheel-feed, copies of the Singer varieties, and of wheel-feed machines.

R. M. WANZER, *Hamilton, Canada.*

This exhibit included a number of machines of different construction. The "Wanzer F" machine had, in the overhanging arm, a rotating shaft having at its end a disk with crossing grooves, the grooves being crossed at a point eccentric to the centre of the shaft. A link provided with two rectangular swiveling-blocks entered these grooves, and being connected with the needle-bar and these devices, denominated a trammel motion, operated the needle to impart to it the dip motion. A vibrating lever, operated by a cam on the rotating shaft, acted to take up the slack of the thread as the needle descended, to give up its slack after the point of the needle entered the material, and, as the needle ascended, it and the needle-bar acted to take up the loop. The stitch was drawn taut and finished by the upward movement of the needle-bar after the take-up stopped in its upward movement. The shuttle-race, made as a separate piece, was adjustable on the machine. A link connected the upper rotating shaft with an arm of a rock-shaft provided at its outer end with an arm and friction-roller, and the roller entered an inclined slot or way made in the side of and moved the shuttle-carrier. The cam and arm operated to move the shuttle rapidly forward and through the loop, and then to move it slower until the stitch was drawn taut, when it was returned. An incline on the shuttle-carrier moving-arm lifted the feed. An eccentric on the main shaft was connected by a rod with and oscillated a link, pivoted at the upper end of an arm of a rocking-frame, and the frame, as it was vibrated, caused a forked vertical arm placed at its outer end, and connected with the feed-bar by a pin, to move the feed-bar horizontally. This link, oscillated from the eccentric on the main shaft, had a movable fulcrum by which to lengthen or shorten the stitch, or to reverse the feed, if desired. The position of the variable fulcrum was regulated by a stop, so as to insure the same length of stitch when the feed was reversed. "Wanzer E" is a larger machine than "Wanzer F," and has a wheel-feed. "The Little Wanzer" is a hand-operated shuttle-machine provided with upper and lower rotating shafts geared together. The needle was operated by a heart-cam. A crank at the end of the lower shaft was connected by a link with a pivoted shuttle-carrying arm adapted to be vibrated in the arc of a vertical circle. A spring at the back of the carrier held the

shuttle against the race-face. One horn of the shuttle-carrier was movable by means of a thumb-piece to permit the removal of the shuttle. It had a four-motioned feed of the usual construction. In the "Wanzer A" the needle mechanism was as in the "Little Wanzer." A crank-pin or disk at the end of the lower shaft operated an arm connected with and arranged to move the sliding shuttle-carrier. It had a four-motioned feed.

HUSQVARNA ARMS MANUFACTURING CO., *Stockholm, Sweden.*

This company sent copies of the Weed sewing-machine and Family Favorite. They were not well finished.

JOHN HEDLAND, *Sweden.*

This exhibit consisted of copies of the Singer and one Wanzer machine. The workmanship was not equal to that of the original machines exhibited by their proper owners.

C. MÜLLER, *Germany.*

This exhibit consisted of copies of Singer machines, arranged to be operated by treadle and by hand, and a chain-stitch machine having a hook of the Wilcox & Gibbs pattern. The needle-bar in the last-mentioned machine was driven by a rotating shaft and heart-cam. It was a hand-machine.

POLLARD & SCHMIDT, *Hamburg, Germany.*

In this exhibit were copies of the Singer and Wheeler & Wilson machines. The Wheeler & Wilson machines were slightly changed as to the devices for regulating the length of the feed-stroke and stitch. One Wheeler & Wilson machine had an embroidery-attachment provided with vibrating crossing thread-carrying arms adapted to present their threads upon the fabric to be stitched thereto by the needle-thread. Some Wheeler & Wilson machines were arranged as hand-machines. One machine employed a straight needle and shuttle, and was adapted to stitch button-holes. The shuttle, held in a carrier, was reciprocated in the direction of the length of the cloth-plate by means of a cam-grooved hub that vibrated an arm connected by a link with the shuttle-carrier. A four-motioned feed of ordinary construction moved the material. The head in which the needle-bar was reciprocated was pivoted at its top, and was vibrated after each ascent of the needle, so that the needle alternately penetrated the fabric back from the edge of the slit and then descended through the slit, its loop being entered each

time by the shuttle. The needle-bar was operated by means of a vibrating arm moved by a cam-grooved hub. The link connected with the head, in which the needle-bar was reciprocated, was connected with the upper end of an adjustable two-part vertical lever, operated by a face-cam on the main shaft, the lever being adapted to regulate the vibrations of the head, and the extent of the stitch back from the edge to be covered.

WILKIE & OSBORN, *Guelph, Canada.*

In the machine exhibited the needle-bar was moved as in the Howe machine. A second grooved cam-hub on the main rotating shaft received an anti-friction roller on an arm pivoted to the under side of the cloth-plate, and extended across the main shaft at right angles. The free end of this arm was connected by an adjustable link with a reciprocated shuttle-carrier lengthwise of the cloth-support. The four-motioned feed-bar was moved by a vertical lever actuated by a crank-pin at the end of the main shaft. The vibrating take-up lever was operated by the needle-actuating arm. Tension was produced, upon the upper thread, by passing it between two disks on a pin, one being pressed toward the other by a spring. A lever, connected with the spring-pressed disk, had an eye at its outer end through which the thread was passed on its way from the spool to the needle. In this way the strain on the thread, should it be caught in any way, served to reduce the pressure of the disk. The treadle-holding portion of the frame was pivoted above or near the knee of the operator, and the treadle or foot-piece could be moved toward or from the operator and be fixed in any desired position according to the length of limb.

O. ST. AMANT, *Quebec, Canada.*

A new Wheeler & Wilson machine, with a mechanism added to move the feed according to the requirements of a pattern-wheel. A pattern-wheel, with projections and depressions arranged according to the desired pattern, was made to operate the feeding device through a system of levers adapted to move it backward or forward, or to the right or left, or in a direction the resultant of a forward and lateral motion. A great variety of ornamental stitches could be produced by the devices contained in this machine. It was not in operation.

R. KIEHLE, *Leipsic, Germany.*

A machine for stitching leather. The cloth-supporting plate was arranged about an upright post, having at its top a circular race one

and three-eighths inch in diameter, and containing a circular shuttle. This shuttle was held by a carrier at the upper end of a vertical shaft, provided at its lower end with a pinion, and moved by a vibrating toothed segment, the shaft imparting to the shuttle a rotary, reciprocating movement. The needle-bar was connected with a rock-shaft through a link, and was reciprocated by the rock-shaft in the overhanging arm. This rock-shaft was connected by a link with the lower and driver-shaft of the machine. The feed device consisted of a vertical lever pivoted centrally, extended up within the post, and provided at the top with a serrated surface. This feed device was raised and lowered with relation to its fulcrum, and vibrated by means of cams at the end of the lower rotating shaft. Feed was adjusted as to length of stitch by means of a machine-screw and screw-driver. The flat presser-foot was lifted at each stitch.

H. P. HENDRICKSON, *Copenhagen, Denmark.*

A novel machine for sewing gloves. A tubular arm inclined somewhat from a perpendicular, and about three-eighths of an inch in diameter, had at its upper end a cylindrical shuttle five-sixteenths of an inch in diameter and five-eighths of an inch long. The shuttle was driven from a pin at the upper end of a rotary reciprocating shaft, twisted at its shank and embraced by a yoke, the reciprocations of which operated the rod after the manner of the looper-rod in the Grover & Baker machine, A flat cloth-support might be placed about the upper end of this post if desired. The needle-bar, operated by a heart-cam and crank, was placed at an angle of from thirty to forty degrees from a perpendicular. The presser-foot, serrated at bottom had four motions imparted to it, thereby converting the presser into a four-motioned top-feed.

E. CORNELY, *Paris, France.*

In this exhibit was the Bonnaz machine, adapted to embroider cloth with a chain-stitch, and to stitch braid or chenille upon the cloth in fancy patterns. A hooked needle was supplied with thread at each descent below the material by a rotary reciprocating thread-carrier, and the thread was drawn above the cloth. The loop so formed was held above and upon the surface of the material until the needle descended within and drew a new loop up through it. The fabric-feeding foot was universal as to the direction of its movement, and consequently moved the fabric in any desired direction from the needle, thereby permitting the stitching to follow any pattern or design printed or stamped on the fabric. A crank-handle controlled by

the operator changed the direction of the feed according to the design upon the fabric to be embroidered. The invention is fully described in United States patents Nos. 83,909, 83,910, 148,182, and 153,142. The machine was of excellent workmanship and materials, and by it most elaborate patterns could be easily and beautifully embroidered on any kind of fabric. These machines may be found in the United States at Lucius Thompson & Co.'s, New York, N. Y. It is the best machine yet made for the work for which it is specially designed.

—— PETIT, *France.*

An exhibit of the Bonnaz machine, a copy of the machine exhibited by Mr. Cornely, and copies of the Howe machine.

B. B. TURNER & Co., *Brussels, Belgium.*

A Bonnaz machine; a sewing-machine for bags and sails, substantially like the one exhibited by Kimball & Morton; and a glove-sewing machine.

These machines were not made by Mr. Turner, and consequently were not before the Judges for award.

A very interesting machine for sewing books was exhibited by Henry G. Thompson, of Milford, Connecticut, in Group XIII.

In Group XII. were a number of machines for sewing leather by means of waxed threads. They were included with leather and leather-working, and did not come within Group XXII. Among these machines was the celebrated Sole-Sewing Machine, made by the McKay Sewing-Machine Association, of Boston, Massachusetts. Before this machine was invented nearly all the shoes worn in this country were made by hand, a small proportion only being made on pegging-machines. The manufacture of sewed shoes was carried on by operators all over the New England States, the work being sent wherever help could be found. After the invention of this machine large shoe-factories were organized, each proprietor being then enabled to sew and perform the entire work within his own establishment. By foot-power an operator may sew from five to eight cases per day, and by steam-power from six to fifteen cases, sixty pairs to a case. This machine may be run at the rate of from four to five hundred stitches per minute, and perform good work. It is understood that there have been sewed on these machines, in the United States alone, about 304,843,060 pairs of shoes.

In the United States straw hats are usually sewed by machines

specially adapted for the purpose. Some companies in the business employ several hundred hands, but none of them exhibited their machines. The straw is delivered automatically to the needle by a proper guide. The hat is commenced at the crown or at the brim, and each round or circular layer of braid is presented upon the edge of a layer already stitched. The stitch is peculiar as to its formation, and appears but little, if at all, on the outside of the hat, but on the inside the stitch is long. A hat can be sewed into any usual shape automatically.

Other special machines in the United States form and sew a great variety of different kinds of trimmings, ruffles, etc., for ladies' wear, tape trimming, etc.

The different machines were considered under various heads, as: quantity and quality of work done at the time, only such work being considered; simplicity of parts and motions; adaptability to different classes of work; quality of workmanship and materials; public estimation; originality as evidenced by history of development; symmetry, etc.

Most sewing-machine companies illustrate in their instruction books the mechanical details of their machines. These illustrations are so accessible that it is unnecessary to accompany this report with drawings.

The so-called sewing-machine combination was formed in 1856, between the Howe, Singer, Wheeler & Wilson, and Grover & Baker Companies, as a settlement of all pending suits and controversies that already threatened to consume in costs all that each might make. By this compromise Howe was to be paid by the others a royalty of five dollars on each machine sold in the United States. Each company retained the right to make a certain machine. For instance, Wheeler & Wilson were to make a rotary-hook machine and were to move the needle by means of a vibrating arm, and the Singer Company were to make a machine in which the needle-bar should be moved by a rotating shaft in the overhanging arm. Prices were regulated, and all joined to defend the patents owned by each company if infringed by others. But few licenses were granted. By this agreement competition in price was avoided, and thereafter each company aimed to so improve and perfect its own peculiar machine that it would be selected instead of others.

WATCH-MAKING MACHINERY.

BY EDWARD H. KNIGHT.

The manufacture of articles by special machinery for each part, the pieces being subsequently assembled to form the finished product, has become generally known as "The American System," on account of the proximate perfection to which the plan has been carried in this country.

It was perhaps first suggested by the French general Gribeauval, who constructed the carriages of field-pieces so that in a given class of gun-carriages the parts were interchangeable, and all uninjured pieces of a disabled gun-carriage could be used in substitution for corresponding parts which might have become damaged in other guns. It is not easy now to determine to what extent this was carried, but the idea does not seem to have soon met with general acceptance, nor, indeed, to have attracted much attention.

It was again suggested by Hall, of North Yarmouth, Massachusetts, whose breech-loading firearms were supplied to the United States Government to the number of 10,000 between the years 1811 and 1839. It is not probable that the system of special machinery was developed to any great extent by Hall, but in the hands of Eli Whitney, of Whitneyville, Connecticut, it received its present impress. Mr. Whitney, after his ill treatment in the matter of his cotton-gin, contracted to supply muskets to the United States Government, and stands *in loco parentis* to the present system.

In Colonel Colt's revolver-factory, in Hartford, Connecticut, the method was still further improved and carried to greater detail, and the excellence of arrangement of that establishment seems to have first attracted public attention to the new departure. The system spread to other factories and then to other industries, notably to the sewing-machine works, the best of which are conducted on this plan. Eventually the system was adopted in the building of locomotives and many other smaller machines and implements of metal and of wood, which it is not necessary to mention. The markedly American character of the system may also be inferred from the fact that the arms-factories of the English and German Governments were fitted up with special machinery built in this country.

The manufacture of watches on the "American System" of interchangeable parts originated about 1850 with Aaron L. Dennison and Edward Howard, of Boston, Massachusetts. The factory was started in Roxbury, Massachusetts, but, on account of the dust, was removed to Waltham, Massachusetts, where it yet remains, the works occupying

nearly two acres and employing about 900 people, half of whom are women. The magnitude of the works, the novelty, accuracy, and variety of the several machines, and the extension of the system to every portion of the instrument, will justify a detailed description of the processes of manufacture.

The manufacture is divided into a number of departments, in which the different parts of a watch are separately produced.

In the *press-room* most of the pieces, whether of brass, steel, nickel, silver, or gold, get their crude forms from punches and dies. The sheets of rolled silver are punched to make blanks for the various parts of the cases; the blanks for watch-plates and bridges are here struck out of the plate, cupped and punched; here are also made blanks for the wheels of the train, the rims of the steel balances, steel blanks for the chronometer balances, ratchets, clicks, hands, yokes for stem-winding works, and scores of other special parts, which go to all the various departments of the factory.

In the *plate-room* the frame of the watch is made complete. The plates of a watch form its foundation or frame, the various parts all being directly or intermediately attached to it. The frame consists of the upper and lower plate, barrel-bridge, balance-bridge, and three pillars. The plates are made from blanks of white sheet-brass, turned and punched; the turning is done in a succession of lathes for special portions of the shaping, the dial-feet-holes, pillar-holes, and pivot-holes being punched at one stroke in a die-press. The engraved name and number of the watch is also given in this room. The frame then passes to the train-room.

In the *train-room* the barrels and centre-wheels are prepared and fitted in the watch. The barrel is turned out of the solid and the gear cut on its edge, forming the main wheel. The blanks for the centre, third, and fourth wheels having been struck out in the press-room,—arms, hubs, and rims at one blow,—the wheels are here finished. The blanks are slipped on a mandrel, to the number of thirty to forty at a time, and cut in an engine, a tooth at a time through the whole set, the mandrel being automatically moved for each tooth, the number of impulses in a full rotation being equal to the number of teeth in the wheel; the machine then stops. The pinion, its arbor and pivots, are turned from a piece of steel wire, and the pinion-teeth are cut in a manner similar to those on the wheels. The wheels are then secured on their staffs in staking tools, brass collets being attached to secure them more rigidly. In this room are made the balance-staffs to hold the balance-wheels, which are made in another department. Here are also made winding-cups, dial-feet, jewel-set-

tings, pallet-arbors, barrel-arbors, wheel-collets, and some other small parts.

From the train-room the watch goes—what there is of it—to the jeweling-room; but, simultaneously with what has been described, a number of other departments have been working on special parts which meet the parts thus sent from the train-room; some of these may be noticed:

The *jewel-making-room.* Here the round jewels for the train are made and fixed in their settings. The jewels are sapphires, rubies, chrysolites, and garnets. The rough stones are sawed into slabs by gang-saws charged with diamond-dust. The thin slabs are then built upon each other and sawed into slips, the slipped are scratched with a diamond and broken into squares on the line of incision. The corners are nipped with a steel tool, to give them a general rounded shape. Each piece is then cemented on the end of an arbor in a delicate lathe, which has a drill in the tail-stock and a shiftable slide-rest. The back of the jewel being cemented to the end of the arbor in the head-stock, the piece is turned to a curve by a swinging motion of the lathe-tool stock which holds the diamond-cutter; the cup in the face of the jewel is turned by a shaped diamond tool; the face and cup are polished with diamond-dust; the pivot-hole drilled part of the way through, and the curve on the back of the jewel made as far as the lathe-arbor to which the jewel is secured will allow. The centre of motion of the swinging tool-post is changed for the latter purpose. The jewel being then detached and reversed, the hole is completed by drilling to meet the drill-hole partly made from the other direction, and the jewel is finished by flatting and polishing on the back.

The setting is a small piece of brass with a drilled hole to hold the jewel, which is burnished in with a lathe tool. The outside is then turned, taking the pivot-hole as a centre.

The pivot-holes vary from $\frac{1}{250}$ inch—which is 10° of the fine gauge referred to elsewhere—to $\frac{8.5}{250}$ inch. The drill for this purpose is made of tempered steel wire drawn on the premises, and the finer size mentioned may be compared to a fine human hair. When this steel hair is used for drilling jewels the wire requires no other facet than its circular end, but for drilling steel it is ground on a lap with diamond-dust to the regular obtuse-angular shape, with a point and pair of edges. The wire is made with a steel draw-plate, though diamonds and sapphires are used for other wire, as well as for making the flat hair-springs from steel wire. The jewels go to the jeweling-room to meet the watch-frame and train.

In the *steel-finishing-room* various parts are made and sent to the

assembling department. The work here includes hands, regulators, hair-spring studs, stem-winding works, ratchets, clicks, click-springs, etc.

In the *balance-room* are made the compensation balances for the superior movements. The steel blank is turned and set in a capsule to receive its rim of brass, which is melted on. The balance is then turned off, cupped, and crossed-out, leaving the arms. The division of the rim in two places and the regulation follow in another department, the escapement-room. The balance-wheel undergoes eighty-four distinct operations.

The *escapement-room.* This room receives the balance from the balance-room and the balance-staff from the train-room; the punched blanks for the scape-wheel, the rollers, pallets, and levers are sent here from the press-room. Here are made the roller with its jewel, the lever with its pallet and jewels, and the scape-wheel. The pallet receives its pair of jewels from a delicately-constructed instrument which holds them in exact position to be cemented in the slits of the pallet made to receive them. The completed escapement goes to the jeweling-room.

In this room is drawn the wire for the hair-springs of the balance, and the springs are here made complete. The wire of various gauges for different classes of watches is drawn between two diamond studs whose faces are nearly flat. The wire is drawn to a ribbon of a thickness of from 5° to 6° of the fine gauge described presently. From two to four of these springs are then coiled in a box, which is hermetically sealed and heated in a crucible bath; after taking out and cleaning they are slipped into each other and drawn to a blue temper.

The compensation balances are finished and regulated in this room. The scales used for the accurate determination of the weight of the balances, hair-springs, and balance-screws have a peculiar bearing, the pivots of the beam resting upon the peripheries of relatively large wheels whose pivots are jeweled. The scale turns instantly with a weight of $\frac{1}{100}$ of a grain, and gives a visible response to a weight of $\frac{1}{1000}$ grain; the weight used in the latter case is a short length of human hair, ten of which go to make up the weight of a small square of aluminium-foil. That square is the $\frac{1}{100}$ part of a square sheet of foil weighing one grain.

The compensation screws are the smallest made in the factory, and weigh 150,000 to the pound. Their threads are also the finest made, being 220 to the inch. These screws are perhaps the most remarkable example of value conferred by mechanical work upon raw material. The steel is worth 60 cents per pound, and the screws made therefrom

are sold at $3.00 per gross of 144,—say 150. As there are 1000 gross in a pound,—1000 gross at $3.00 = $3000.00, which, divided by .60, gives 5000 as the ratio of increase in the value of the pound of metal.

The number of varieties of screws made in the factory is 114 for all the kinds of watches. The number of screws in a full-jeweled full-plate watch is 33.

The *dial department* involves a totally different set of operations and apparatus. The dial-blank is a copper disk struck up with a rim and holes; feet are set on the back, and the disk face is filled with enamel which is melted in a muffle; being then ground on the face, it is fired for polish, figured, circled, and lettered with black enamel, which is fixed, and has its color developed by firing in the muffle.

The *jeweling-room*. To this room comes from the train-room the watch frame with its barrel and centre-wheel in place; also the train-wheels fitted on their pinion-staffs and various other parts of the watch. The jewel-making-room contributes its round jewels ready set. The escapement and balance complete come from the escapement-room.

At this point the individuality of the watch comes to be recognized; the frame has already its name, number, and other insignia, and a suite of train-wheels and an escapement are here selected for it and jeweled-in, and from this point the parts of a watch movement travel together, being kept in tray-pockets or boxes, so that they never become dissassociated.

The jewel-settings are here placed in the plates, having shoulders which rest in countersinks; the jewel-screws having heads which rest on the settings. The end-shake of each staff is determined in this room by means of a machine, each one being tested, so that although the lengths of the staffs in a given movement may not be exactly uniform, they have nevertheless the same amount of end-shake. This is accomplished by the depth of the turning on the shoulder of the jewel-setting, so that it shall sink more or less deeply into the top-plate. The depth in the other plate is uniform, the adjustment being made in but one of the plates.

The selection of the jewels is made by gauges, one for measuring the diameter of the pivot and the other that of the hole. A register is kept along with the number of each watch of the size of each pivot, and a jewel of the appropriate size is selected to fit it, an allowance of from 0.5° to 1.5° of the fine gauge being made for side-shake. Should such a jewel be broken, the part can be replaced by simply sending to the factory the number of the watch and the name of the

wheel whose jewel is injured. The hole-gauge is a fine tapering needle, on to which the jewel is slipped, and, stopping at a point determined by its diameter, pushes in the spring-pin, which has a pointer traversing upon a graduated scale which is marked in degrees of the fine gauge; $1° = .0003937$ of an inch. The pivot-gauge is a taper slot in a steel plate, graduated on the edge; the pivot is slipped along in the slot until it rests against the sides and can go no farther. The number opposite to the middle of the pivot is its gauge, corresponding to the measurements of the hole-gauge.

The fine gauge used in the factory was designed to have for its unit $\frac{1}{2500}$ of an English inch, but proved to be very slightly below that measurement, so that it exactly agrees with the metric system. Instead of being, as it was intended, $\frac{1}{2500} = \frac{4}{10.000}$ of an English inch, it proved to be $\frac{3.937}{10.000}$, or .0003937 inch, $= \frac{1}{1000}$ of a centimetre or one centimillimetre; the $\frac{1}{100.000}$ of a metre. To compare the smallest non-microscopic object with the largest in reach, the unit of the gauge is a millionth of a millionth of the distance from the equator to the pole measured on a meridian; statable in figures, $\frac{1}{1.000.000.000.000.000}$, which must be very satisfactory to those who delight in round numbers.

The small steel drills used for making the pivot-holes in jewels are No. 10 of this gauge. Other gauges are used reading to less minute divisions: $1°$ of the common upright gauge $= \frac{1}{100}$ centimetre $=$ .003937 inch. $1°$ of the upright gauge $= 5°$ fine gauge (or $\frac{1}{2}°$ of the common upright gauge) $= \frac{1}{200}$ centimetre $= .001968$ inch.

The *springing-room*. The watch having been received from the jeweling-room receives in this room its main- and hair-springs. The latter are carefully tested for evenness, strength, and weight, and the balances being likewise weighed, one of each is selected, bearing the proper relative proportions to each other, and the pair becomes associated for life, a *mariage de convenance* which has the happiest effects. In the springing-room the watch movement is entirely put together and set running. It is then taken down and sent to the *gilding-room*, where the brass parts are all gilt by electro-battery and bath, the pieces of each watch being scrupulously kept together.

In the *finishing-room* the watch is set up for the second and last time; and thence, if of superior quality, it goes to the *adjusting-room*, where it stays from four to six months to be adjusted for heat, cold, isochronism, and position.

The *casing-rooms* are for the manufacture of the portions consisting of the centre cover, cap, back, and bezel in the die-press, which has a mechanical effect of 2300 tons. The engine-turning, springing, and pendant-fitting are in other departments.

The number of parts in a full-plate, full-jeweled watch, counting the minutest detail of pins, dial, and hands, is 151.

The watches made are of 15 general kinds, distinguished by shape and size. These are subdivided into 150 varieties, in which the differences are of finish, number of jewels, construction of the balance and escapement, etc. This is independent of casing. About 2000 machines are used in the factory, and nearly 1000 distinct processes are used in producing a complete watch. The production is about 350 movements per day, or 105,000 per annum. The production of cases is about 4000 per month. More than half of the movements are sold uncased.

Twelve thousand watches are in progress at a time, the parts or the watches being forwarded in regular succession. Every watch is recorded in each room as it proceeds, so that the place of any watch is always ascertainable at any moment. When a bill of any kind of watches is called for, the number of its kind in progress can be at once known, and the condition as to progress of each of the number. The stock in hand on any day is immediately ascertainable.

The factory-work was elucidated at the Centennial Exhibition by a series of machines in motion, including the following:

Screw-making machines, screw-polishing machines, wheel-cutting engine, damaskeening machine, pinion-cutting machine, pinion-polishing machine, pinion-leaf-polishing machine, staking-tools, opening-wheel machine, colleting-wheel machine, jewel-turning lathe, jewel-drilling lathe, etc., etc.

The machines gave some idea of the nicety, novelty, and ingenuity of the mechanism employed, but could give but little impression of the variety and number of the machines in the factory. In the effective substitution of machines for hand-methods, the manufacture of watches calls for greater fineness and ingenuity than is implied in the adaptation of the machine-method in any other manufacture. It is not easy to characterize within moderate terms the wonderful subtlety of invention and the extreme delicacy and aptitude of the machines, some of which deal with details of construction so small that the work and effect can only be observed with the assistance of powerful glasses. The result is the most wonderful series of machines anywhere to be found, and the product in watches is the most evenly excellent in quality, obtained in the most economical manner.

In the same class of machinery, but adapted merely for the hand system of watch-making and for repairing, were a number of combi-

nation lathes and chucks, depthing and jeweling tools, etc., exhibited by several American and foreign firms.

The following were considered worthy of special mention, and exhibited great accuracy and beauty of workmanship, as well as ingenious adaptation to the purposes intended. None of them were shown in use or in motion. The exhibitors were:

John Stark, Waltham, Massachusetts, U. S.

American Watch-Tool Company, Waltham, Massachusetts, U. S.

St. Vautier & Sons, Carouge, Switzerland.

Louis Borel-petitpierre, Couvet, Neuchâtel, Switzerland.

KNITTING-MACHINES.

BY G. W. GREGORY.

The exhibition of knitting-machines was not as full and complete as it should have been, and fell far short of representing the state of the art in the United States and Europe, specially in "power machines."

The art of machine-knitting dates from about the year 1589, when the first machine was invented by William A. Lee, A.M., of St. John's College, Cambridge, England. The first machine is believed to have been established near Nottingham, England; but Lee, receiving but little encouragement at home, transferred his machines to France, and the manufacture of hosiery by power was not again carried on in England until about 1640. Knight's *Mechanical Dictionary* contains a very carefully-prepared article on the subject of knitting. It states that cotton stockings were first knit by hand about 1730. Most stockings now worn are in whole, or in part, of cotton.

The comparatively recent machines for domestic use, adapted to knit both circular and flat webs by a narrowing and widening process, were well represented and exhibited by competent operators.

The great knitting centres of the United States are at Philadelphia, Pennsylvania, at Cohoes, New York, and thereabouts, and in various villages in Massachusetts and New Hampshire. New Jersey contains one large corporation located at New Brunswick, at which place American machines produce goods equal to the best of foreign manufacture.

THE LAMB KNITTING-MACHINE CO., *Chicopee Falls, Mass.*

This company exhibited their "family machine," employing two parallel rows of latched needles, separated sufficiently to permit the

passage of the work between them, but close enough together to connect the two rows of knitted loops at each end the series of needles, as is necessary for the production of a tubular web by the needles of each series operated consecutively. The needles were held in grooves in inclined beds; the upper ends of the needles worked between jacks on a pivoted jack-bar, made removable in order to obtain access to the loops on the needles; and the needles were operated by means of cams on a reciprocating frame connected by a link with a hand-operated crank. The cams, of peculiar construction, located between the frame and the needle-bed, at each side thereof, were automatically changed or shifted, when necessary, by adjustable stops at the ends of the needle-bed, the stops being placed so as to strike the end of a slide-plate slotted to receive a pin projecting from each of the V-shaped cams adapted to lift the needles. Each V-shaped cam had at each side of it a drawing-down or "wing-cam," to depress the needles. When both series of needles were operated at each reciprocation of the frame and cams, a ribbed flat web was produced. When the needles at but one side of the bed were moved by one set of cams as the frame was moved in one direction, and the needles at the other side were moved by the other set of cams as the frame was operated in the opposite direction, then a tubular web was knitted. This machine was capable of rapidly knitting and fashioning stockings of different sizes, and of producing knitted webs and garments having both plain and ornamental or fancy stitches of great variety. In this feature it had no rival, and was considered the best machine for family use.

This company also exhibited a larger machine specially adapted to knit Cardigan jackets and fabrics in which it was desired to employ the "polka" and "one and one" rib-stitch. The needles were placed substantially as in their usual machine.

The cam-carriage was reciprocated by a rotating screw-shaft provided with a right-and-left leading thread, that engaged a finger projecting from the carriage. The carriage had two sets of cams at each side.

When knitting the "polka stitch," one set of cams on one side was fully open, and in such position did not move the needles far enough to pass their latches through the loops held upon their shanks; but the second set of cams following that set, being further closed, operated the needles far enough to free the latches, so that the needles, when again drawn down, drew the last loop through two loops then held on their shanks.

The screw-shaft, and consequently the cam-carriage, derived its motion from a band-pulley having at its sides a friction-clutch con-

nection, controlled, as to its engagement or disengagement, by a knuckle-jointed lever. Attached to this jointed lever was a notched rod, that was extended along the whole length of the bed on its upper side, over the front needles and under the carriage. When the yarn broke or ran out, projecting feet on the pivoted yarn-guides dropped into notches of the notched rod, and then the further movement of the carriage moved the notched rod, disconnected the friction-driving-pulley, and stopped the machine. A register on the machine could be set to disconnect the friction-pulley and stop the machine at the completion of any desired number of courses.

One or two threads could be used with each of the two sets of cams. The front plate or needle-bed was connected with a lever, by which it might be moved or shifted horizontally the distance of one needle to the right or left to "rack" or cross the threads, in order to produce an edge-finish on the end of the ribbed web, which in this machine was flat.

To form "one and one" rib, both sets of cams were retained in position to operate each needle the full length of its knitting-stroke up and down.

In the formation of the "polka" stitch by this machine, instead of holding the second or "tucked" stitch or loop on the latch as usual, it was held *inside* the hook and under the latch, which strained the yarn less than the old method, and the web could be made slacker and softer, for the double loop could be drawn more than the single loop without breaking the yarn.

The capacity of the machine was stated to be from four to eight dozen jackets per day, according to the grade of goods and style of finish desired.

The following patents are some of those owned by this company: Nos. 39,934, 50,369, and 9621.

CAMPBELL & CLUTE, *Cohoes, N. Y.*

A knitting-machine for shirt-work, employing bearded needles, sinkers, pressers, and inside leading, and cast-off burrs, as usual. The needle-cylinder, and overhanging, automatically operated take-up frame, were connected together so as to be moved exactly in unison. The take-up rollers moved with equal surface speed, to draw equally on the sides of the flattened tubular web, and the extent of their movement was regulated by the slack of the web as the latter was produced.

Each machine had four feeders, and was provided with novel devices for moving the pressing-wheels out of operative position with

relation to the beards of the needles should a thread break, the movement of the presser preventing the beards from being pressed; and consequently the work was retained on the needles, notwithstanding the thread was broken. Aside from this last feature, the machine was very old.

DANA BICKFORD KNITTING-MACHINE, *New York, N. Y.*

A circular machine, having a ring provided with needle-operating cams. The cam-ring was adapted to be operated by hand continuously in one direction to knit a tubular web, or to be reciprocated less than a revolution in opposite directions to produce a flat web. By alternately depressing the needles at each end of the series used when the cam-ring was reciprocated, a narrowed portion could be formed for one portion of a heel or toe, and then by gradually returning such needles to operative position, a widened counterpart to the narrowed portion could be produced to complete a heel or toe. The machine was well adapted to knit woolen stockings, and by removing a portion of the needles and changing the loops laterally from some to other needles, ornamental stitches could be produced in circular and flat webs.

The Bickford patents are numbered 68,595, 80,121, 92,146, 84,472, 131,386, 131,387, 132,382, 136,639, 162,886, 168,216, and reissues Nos. 6423 and 6424.

FRANZ & POPE KNITTING-MACHINE CO., *Bucyrus, Ohio.*

A hand-operated circular machine adapted to be rotated as it was desired to produce tubular work, or to be reciprocated to fashion the heel or toe of a stocking by widening and narrowing as above described, with reference to the Bickford machine.

The Franz & Pope machine differed from the Bickford machine, on which it was an improvement, chiefly in the construction of the cams for operating the needles, they being simpler than in the Bickford. The two machines operated equally well. The Franz & Pope was the simpler of the two.

Patents owned by this company are numbered 61,608, 69,775, 69,776, 73,697, 88,027, 91,214, 91,215, 99,425, 99,426, 102,529, 105,187, and 123,687.

HAWLEY & BRANSON CIRCULAR KNITTING-MACHINE, *Chicago, Ill.*

This machine was manufactured under patents to Mr. Branson, of June 18, 1872, and March 31, 1874. The cam-cylinder had a stitch-cam and two pivoted needle-elevating-cams, and the machine could

be made to knit a tubular web by revolving the cam-cylinder continuously, or the cam-cylinder could be reciprocated part of a revolution backward or forward, for flat or other usual work. The lower edge of the stitch-cam, instead of being made V-shaped or horizontal as usual, was upwardly curved between its extreme ends, to permit one or two needles next back of the lower extreme forward or working end of the stitch-cam to rise, when a needle in the act of drawing a new through an old loop met a knot. This provision allowed the new loop to be partially formed from the thread held by the needles so permitted to rise, which thereby prevented the thread from being broken. The lower end of the stitch-cam was broad enough to hold down four needles, which was considered advantageous as compared with a V-cam, in the more even formation of loops, for the needles last drawn down were then less liable to shorten the loops of the adjacent needles, or "rob" them of their share of thread. The thread-carrier, connected with the cam-cylinder so as to change its position at each change of direction of movement of the cylinder, to place the carrier in advance of the stitch-cam, was fitted into a slotted plate at the upper portion of the cylinder, and was stopped just before the cylinder completed its movement, by striking against the butt of a needle drawn up and held in the path of the thread-carrier shifter.

This machine was very simple in construction and capable of producing a good variety of work, and was sold at a lower price than any other circular machine exhibited.

C. R. Tuttle Circular Knitting-Machine, *New Brighton, Pa.*

This machine contained a circular series of vertically reciprocating latched needles operated by cams on the interior of a cam-cylinder. The cam-cylinder could be rotated continuously, or in opposite directions as usual, to knit flat-work or gores for heels and toes.

To knit ribbed-work on this machine, a conical needle-bed grooved to receive ribbing needles was swung into position within the circle of vertical needles, and a projection on the conical bed then engaged a recess or lug at the interior of the vertical needle-bed, so that the movement of the latter carried with it the bed for the ribbing needles. For plain knitting, the cam-cylinder or the vertical needle-bed could be rotated while the other remained at rest.

When ribbed-work was being knit, it was necessary to rotate the bed. For such work every third needle was drawn up out of the main cylinder and turned and inserted into a groove in the conical bed, and such needles so transferred with their loops to the conical bed served as ribbing needles. After the proper length of ribbed-

work was produced, the needles were all re-transferred to the main cylinder. By changing the needles in this way, it was possible to knit a stocking with the rib-top and plain-leg, and, if desired, fancy ribbed stripes of various lengths and widths could be formed in the plain knitted ground. Patent No. 149,813.

GIMSON & COLTMAN CIRCULAR RIBBING-MACHINE, *Leicester, England.*

This machine used a vertical and horizontal circular series of latched needles, and was for the production of heavy work, Cardigan jackets, etc. It employed twelve feeders for "polka-stitch" rib, and half that number for plain "one and one" rib-work. The vertical needles were reciprocated as usual, by cams, on a revolving cylinder. The circular needle-bed for the vertical needles was raised or lowered through the action of two rings provided with inclined faces. The cam-plates for operating the horizontal needles were also correspondingly changed by similar inclined rings, these changes drawing the loops more or less, for loosely- or closely-knitted fabrics.

To change from "polka" to plain rib, the cam-plate for the horizontal needles was shifted to the right by hand, until the feeder, which before acted only to feed the vertical or frame needles, was in position to feed both sets of needles, and then the threads which fed the horizontal or machine needles were broken off. To make this change from "polka" rib so as to properly finish a jacket, an annular plate or disk having inclined slots, in which rested pins which projected from the needle-actuating cams for the horizontal needles, was moved so as to draw the cams and horizontal needles back far enough to allow the bed for the horizontal needles to be moved sufficiently to shift the horizontal needles one needle to the right or left, and then the machine was again started to knit as usual, each loop thereby being thrown one loop or rib to the right or left, to cross the stitches and make an end finish. The distance that the horizontal needles were reciprocated beyond the edge of the carrying-bed or plate was regulated by means of a studded ring provided with pins adapted to enter slots in projections attached to the cam-sections. For sleeve-work the number of needles in each ring was decreased, and only two feeders were used.

This firm also exhibited a machine provided with two sets of needles, and adapted to knit "rib-tops" with slack courses, and striped or not, as desired. The thread-carriers were thrown into and out of operation as desired, according to the indications of a pattern-surface. The machine produced excellent work. It was stated that it could produce forty dozen rib-tops of average length in a day of ten

hours. It was patented in the United States, No. 147,372. The machine exhibited was somewhat modified and simplified from the construction shown in the patent.

NEEDLE-MAKING MACHINERY.

BY EDWARD H. KNIGHT.

The display of needles for hand-use and for the various styles of sewing-machines was ample and admirable, exhibits having been furnished by England, Germany, and the United States. The list of awards states the conclusions arrived at by the group having this branch of manufacture in charge. It was not always easy to arrive at a conclusion; but by dint of severe tests and microscopic examination, a determination was reached, based upon the quality of the metal, evenness of shape, excellence of shape, and variety of display. More than a hundred different kinds of needles were shown, the distinctions being founded upon size, sharpness of points, and adaptation to various purposes. Among the latter may be cited the ordinary domestic needle, sewing-machine, tambour, embroidery, darning, packing, surgical, etc. Allied with the needles were numerous other articles associated with them, such as bodkins, and needles for knitting, crochet, and tatting.

The foreign exhibits of needles were far in excess of the home display, as the awards will indicate; but the most interesting exhibit in the class was the machinery for making sewing-machine needles, from the National Needle Company, of Springfield, Massachusetts.

The machines were arranged in Machinery Hall, in the vicinity of the Corliss engine, and the series operated in a regular succession. The list of conditions of the needles is a long one, but may be summarized as:

Blank.
Reduced blank.
Reduced and pointed blank.
Grooved.
Eye-punched.
Hardened and tempered.
Hard-bur dressed.
Brass brushed.
Eye-polished.
First inspection.
Hard straightened.
Finish-pointed.
Finished.

Speaking generally, the needles are of various lengths and patterns, to suit the requirements of different sewing-machines; they are also of various sizes for different grades of sewing. Besides the generic differences, such as straight or curved, and the specific variations, such as long, short, round, pointed, or chisel-pointed, there are

some minor peculiarities of patented needles, and the various sewing-machine firms have their private brands and numbers.

The wire is received in coils of 50 pounds weight, and is passed through the first machine, the straightener and cutter, to take out the bend. It consists of an open revolving cylinder, containing six pins, which pass the axial line, three on each side, alternately. As the cylinder revolves 3000 times in a minute, the wire is very rapidly bent back and forth, the last pin with which it comes in contact being on the central line and leaving the wire straight. A clamp-feed regulated by a cam advances the wire, a revolving head forms the butt, and a cutter removes a blank of the regulated length: the number of blanks is registered on a dial-plate.

The reducing-machines are three in number, for roughing, dressing, and smoothing. The first two work with coarse and fine emery-wheels, and the third with an emery-belt. The blanks are fed from a hopper on to a grooved endless traveling carrier, which exposes to the action of the emery-wheel that portion of the blank which is to be reduced in diameter to form the shank of the needle, the portion not reduced being that designed to be placed in the end of the needle-bar of the sewing-machine. As the needles travel past the emery-wheel, they are rotated by a pair of reciprocating plates, so that they are equally ground all round. The third machine has an emery-belt, which finishes this part of the operation. The taper-pointing is done upon a succeeding machine, only that portion of the needle being exposed to the emery.

In the grooving-machine, the short groove on one side of the needle and the large one on the other side are made by two circular saws, past which it is fed automatically. The saws are pressed in against the needle, and then withdrawn at such times as will give the required depth and contour to the groove.

Next follows the punching of the eye. The correct position of the needle in the machine is insured by a central plate, which fits into the short groove on the side of the needle shank; the punch descends and passes through the needle into a hole through the central guide-plate.

The hardening and tempering follow; the needles are heated to a cherry-red in a reverberatory furnace with a charcoal fire. The bath is of whale oil. The tempering oven is heated by the surplus heat of the furnace, and the needles are here placed in sheet-iron pans suspended from the arms of a revolving shaft.

The needle may now be considered as having its shape and quality, and the remainder of the processes may be classed as finishing.

The needles are cleaned on an emery-cloth, being held in gangs of about 20 between the finger and thumb, and rotated while being pressed upon the cloth. They are then taken by a flat-jawed tongs which holds 70 at a time, being arranged with the long groove upward, and are held against a scratch-brush of brass wire, which revolves 8000 times a minute, and polishes the grooves: this is followed by a bristle brush. While yet held in the clamps the needles are threaded in gangs on cotton threads, covered with oil and emery, and the needles drawn back and forth in various slanting positions, so that the polishing powder shall act upon all parts of the eye. Being removed from the thread, the needles are cleaned by a revolving hair brush, and then pass the first inspection, the eyes, points, and blades being examined with the aid of a glass. Imperfect ones are thrown aside, and the good ones sent to the hand straightener. In this operation they are rolled on an anvil, at the level of the eye of the operator, who detects any curvature, and corrects it by a tap of a small hammer. The needles then pass the second inspection.

The final operations are finish-pointing on a fine emery, and finish-polishing by a revolving hair brush, with crocus and alcohol. They are then ready for packing.

The machines at the Centennial Exhibition made 4000 needles per day.

REPORTS ON AWARDS.

GROUP XXII.

1. Wheeler & Wilson Manufacturing Co., Bridgeport, Conn., U. S.

SEWING MACHINE.—THE "NEW WHEELER AND WILSON" SEWING MACHINE, MAKING THE LOCK-STITCH, AND EMPLOYING A STRAIGHT NEEDLE, MOVED BY A VIBRATING ARM AND GROOVED CAM; ALSO A DISK BOBBIN AND A ROTATING HOOK, THE LATTER HAVING A VARYING SPEED OF ROTATION BY MEANS OF A DIVIDED SHAFT WITH CONNECTING DISK.

Report.—Commended as unsurpassed in the fine workmanship of its parts, and possessing great originality, great adaptability to different classes of work both on cloth and leather, beauty of stitch, ease and rapidity of motion, and for completeness of display.

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2. Wheeler & Wilson Manufacturing Co., Bridgeport, Conn., U. S.

SEWING MACHINE FOR LEATHER.—THE NEW WHEELER & WILSON SEWING MACHINE.

Report.—Commended for superior quality of work in leather stitching.

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3. The Singer Manufacturing Co., Elizabeth, N. J., U. S.

FAMILY SEWING MACHINES.—A SHUTTLE SEWING MACHINE, EMBODYING THE FOLLOWING POINTS OF CONSTRUCTION, VIZ., A NEEDLE-BAR OPERATED DIRECTLY FROM THE END OF A ROTATING SHAFT IN THE OVERHANGING ARM, A SHUTTLE SUPPORTED IN A SHUTTLE-CARRIER MOVED TRANSVERSELY TO THE FEED BY MEANS OF A CRANK ON A ROTATING SHAFT, A FOUR-MOTIONED POSITIVE FEED, AND A STRAIGHT NEEDLE WITH ITS EYE PARALLEL WITH THE DIRECTION OF FEED.

Report.—A superior family shuttle machine, embodying the greatest number of most approved mechanical devices to impart positive motions to the various parts. Commended for simplicity of construction, good workmanship, quantity and excellent quality of work done, originality, and for completeness of display.

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4. The Singer Manufacturing Co., Elizabeth, N. J., U. S.

SEWING MACHINES FOR STITCHING BUTTON-HOLES.—A SEWING MACHINE SPECIALLY ADAPTED FOR STITCHING BUTTON-HOLES IN CLOTHING AND LEATHER, THE MATERIAL TO BE STITCHED BEING HELD IN AN AUTOMATICALLY-MOVING CLAMP THAT PRESENTS THE EDGE OF THE BUTTON-HOLE TO THE ACTION OF THE NEEDLE, THE LATTER RECIPROCATING IN A LATERALLY MOVING HEAD.

Report.—Commended for quantity and quality of work, automatic action, good workmanship, and originality.

5. The Weed Sewing Machine Co., Hartford, Conn., U. S.

SHUTTLE SEWING MACHINE.—THE NEW WEED SHUTTLE SEWING MACHINE EMPLOYING A STRAIGHT NEEDLE AND NEEDLE-BAR CONNECTED BY A LINK WITH A CRANK ON THE END OF A HORIZONTAL SHAFT IN THE OVERHANGING ARM. THE NEEDLE-BAR OPERATING SHAFT IS CONNECTED BY A LINK WITH, AND HAS A ROCKING MOTION IMPARTED TO IT BY MEANS OF A CRANK ON A LOWER ROTATING SHAFT. THE SHUTTLE, SUSTAINED BY A CARRIER, IS RECIPROCATED IN THE DIRECTION OF THE FEED BY A CRANK AND LINK CONNECTED WITH THE ROTATING SHAFT, AND THE FOUR-MOTIONED FEED IS MOVED POSITIVELY.

Report.—An excellent shuttle machine, possessing originality and simplicity of constructive detail. Commended for fine quality of workmanship and materials, and for great adaptability to both cloth and leather stitching.

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6. Wilson Sewing Machine Co., Chicago, Ill., U. S.

WILSON'S FAMILY SEWING MACHINE.—A SHUTTLE MACHINE EMPLOYING A SHUTTLE RECIPROCATED TRANSVERSELY TO THE FEEDING MOVEMENT OF THE FOUR-MOTIONED FEED; A STRAIGHT NEEDLE AND NEEDLE-BAR MOVED BY A VIBRATING ARM, AND ACTUATED BY A CRANK-PIN WORKING IN A HEART-SHAPED CAM MADE IN THE LOWER END OF THE VIBRATING ARM BELOW THE CLOTH SUPPORT.

Report.—Commended as a good machine for family use, for simplicity of construction, adaptability to a variety of cloth-work, for good work performed, and for workmanship and materials.

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7. The Howe Machine Co., Bridgeport, Conn., U. S.

SHUTTLE SEWING MACHINES.—A SHUTTLE SEWING MACHINE, BOTH THE NEEDLE AND SHUTTLE BEING MOVED BY VIBRATING LEVERS, ACTUATED BY GROOVED HUB-CAMS ON ROTATING SHAFTS.

Report.—Commended for excellency of stitch on cloth and leather.

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8. J. & W. Lyall, New York, N. Y., U. S.

SEWING MACHINES.—A LOCK-STITCH SHUTTLE MACHINE IN WHICH THE VERTICAL NEEDLE-BAR IS RECIPROCATED FROM A ROTATING SHAFT BY AN EPICYCLOIDAL MOVEMENT.

Report.—The most rapidly-running shuttle machine.

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9. Willcox & Gibbs Sewing Machine Co., New York, N. Y., U. S.

SEWING MACHINE.—A CHAIN-STITCH SEWING MACHINE EMPLOYING A STRAIGHT NEEDLE AND A ROTATING HOOK.

Report.—Commended for high quality and great rapidity of work, simplicity of parts, ease of motion, superior workmanship, and for its automatic tension adaptable without alteration to all kinds of thread applicable to the machine.

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10. The Davis Sewing Machine Co., Watertown, N. Y., U. S.

SEWING MACHINE.—A SHUTTLE SEWING MACHINE EMPLOYING A CO-OPERATING VERTICAL UPPER AND NEEDLE-FEED AND LIFTING PRESSER, AND A SHUTTLE SUPPORTED IN A CARRIER AT THE END OF A HORIZONTALLY-VIBRATING ARM ACTUATED FROM A VERTICAL LEVER OPERATED BY A CAM ON A ROTATING SHAFT IN THE OVERHANGING ARM.

Report.—A co-operating upper vertical and needle-feed and shuttle machine, adapted to a variety of thin and thick work. Commended for good work, workmanship, and originality.

11. Johnson, Clark, & Co., New York, N. Y., U. S.

"HOME" HAND-SHUTTLE SEWING MACHINE.—A HAND-OPERATED SHUTTLE SEWING MACHINE, EMPLOYING A STRAIGHT NEEDLE-BAR, OPERATED BY A ROTATING SHAFT AND HEART-CAM, A HORIZONTALLY-VIBRATING SHUTTLE-CARRYING ARM MOVED BY AN ECCENTRIC ON A HORIZONTAL SHAFT, AND A FOUR-MOTIONED FEED.

Report.—A hand shuttle machine possessing simplicity of parts and motions.

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12. R. M. Wanzer & Co., Hamilton, Canada.

LOCK-STITCH SEWING MACHINES.—A SHUTTLE SEWING MACHINE EMPLOYING A ROTATING SHAFT IN THE OVERHANGING ARM AND DRIVING THE NEEDLE-BAR THROUGH A LINK AND TRAMMEL MOVEMENT PLACED ECCENTRICALLY TO THE DISK AT THE END OF THE SHAFT, A SHUTTLE MOVED PARALLEL WITH THE DIRECTION OF THE FEED BY A CRANK ON A ROCKING SHAFT, AND A FOUR-MOTIONED FEED.

Report.—Commended for quality of work performed, and for workmanship.

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13. American Button-hole, Overseaming, and Sewing Machine Co., Philadelphia, Pa., U. S.

SEWING MACHINE.—A COMBINED SEWING AND BUTTON-HOLE MACHINE, EMPLOYING A STRAIGHT NEEDLE ACTUATED THROUGH A VIBRATING ARM AND CAM-GROOVED HUB, A CURVED SHUTTLE RECIPROCATED IN A PLANE PARALLEL WITH THE FEED AND ON A CURVED RACE-WAY. FOR BUTTON-HOLE STITCHING THE SHUTTLE-RACE IS TURNED ASIDE, A VIBRATING ARM, PROVIDED WITH A CURVED THREAD-CARRYING LOOPER, IS MOVED INTO WORKING POSITION, SO AS TO CARRY ITS THREAD THROUGH THE LOOP OF NEEDLE-THREAD AND ABOVE THE EDGE OF THE MATERIAL TO BE ACTED UPON BY A LOOP-SPREADER; ALSO A TRAVELING CARPET-SEWING MACHINE.

Report.—A combined sewing, button-hole, and overseaming machine of simple construction. Also a carpet-sewing machine of original and simple construction.

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14. Remington Sewing Machine Co., Ilion, N. Y., U. S.

BUTTON-HOLE SEWING MACHINE FOR COTTON AND LINEN, EMPLOYING A SINGLE THREAD, AND FINISHING THE BUTTON-HOLE AUTOMATICALLY.

Report.—A button-hole sewing machine made under the Cleminshaw patents, and adapted to operate on cotton and linen goods. Commended for originality and good work.

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15. Kimball & Morton, Glasgow and Dundee, Scotland.

A LARGE SHUTTLE MACHINE FOR SEWING HEAVY SACKS, SAILS, AND TARPAULINS. THE HEAD IN WHICH THE NEEDLE-BAR RECIPROCATES IS MOVED LATERALLY AFTER EACH STITCH, SO AS TO MAKE THE HERRING-BONE STITCH; THE NEEDLE-BAR IS OPERATED BY A ROTATING SHAFT AND HEART-CAM; THE FEED SURFACE IS PLACED ABOVE THE MATERIAL, AND HAS FOUR MOTIONS; THE SHUTTLE IS MOVED TRANSVERSELY TO THE DIRECTION OF THE FEED. ALSO A SEWING MACHINE HAVING A PECULIAR THREAD-CARRYING LOOPER ATTACHED TO A SHUTTLE-DRIVER AND ADAPTED TO FORM AN OVERSEAMING STITCH.

Report.—Commended for quality and quantity of work done, simplicity of parts and motions, quality of workmanship and materials, and for originality.

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16. Hamburg-American Sewing Machine Co., formerly Pollack, Schmidt, & Co., Hamburg, Germany.

A BUTTON-HOLE SEWING MACHINE, EMPLOYING A VIBRATING NEEDLE AND A SHUTTLE.

Report.—Commended for simplicity of construction and originality of detail.

17. **E. Cornely, Paris, France.**

BONNAZ EMBROIDERING MACHINE, EMPLOYING A HOOKED NEEDLE SUPPLIED WITH THREAD BY A ROTARY RECIPROCATING HOOK BELOW THE CLOTH SUPPORT, AND HAVING A UNIVERSAL UPPER FOUR-MOTIONED FEED.

Report.—Commended for excellent quality and quantity of work done; simplicity of parts and motions; adaptability to different classes of embroidering, braiding, and overseaming; very high quality of workmanship and materials; originality, evidenced by history of development of the machine; symmetry, as evidenced by external shape; and for completeness of general display.

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18. **Geo. C. Walters, Philadelphia, Pa., U. S.**

SEWING MACHINE FOR GREEN HIDES.—THIS MACHINE, FOR SEWING GREEN HIDES, EMPLOYS A HOOKED NEEDLE AND CAST-OFF, AND MAKES CHAIN-STITCH. THE HIDE IS MOVED BY TWO ROUGH-SURFACED FEEDING CLAMPS THAT ENGAGE ITS UPPER AND LOWER SURFACES.

Report.—Commended as an efficient machine for the purpose intended.

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19. **The Eickemeyer Hat-Blocking Machine Co., Yonkers, N. Y., U. S.**

MACHINE FOR SEWING SWEAT-LININGS IN HATS.

Report.—Commended for excellent quality of work, simplicity, and originality.

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20. **Geo. C. Howard, Philadelphia, Pa., U. S.**

A FRICTION-BELT GEARING FOR SEWING MACHINES.

Report.—Commended for simplicity of construction and adaptability to varying speeds.

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21. **Hans Peter Henriksen, Copenhagen, Denmark.**

MACHINE FOR SEWING GLOVES WITH A LOCK-STITCH, THE MACHINE HAVING A FLAT AND A TUBULAR WORK SUPPORT.

Report.—Commended for originality.

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22. **F. G. Schmalz, Altenburg, Germany.**

IMPLEMENTS USED IN THE MANUFACTURE OF GLOVES.

Report.—Commended for completeness of general display.

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23. **Lamb Knitting Machine Manufacturing Co., Chicopee Falls, Mass., U. S.**

LAMB KNITTING MACHINE FOR FAMILY USE, EMPLOYING TWO ROWS OF LATCHED NEEDLES, ADAPTED TO BE USED SEPARATELY OR TOGETHER, FOR FLAT OR TUBULAR FABRICS OF DESIRED SIZE.

Report.—A superior machine, commended for simplicity of construction, excellence of workmanship, and adaptability to hosiery and to a great variety of fancy fabrics.

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24. **Lamb Knitting Machine Manufacturing Co., Chicopee Falls, Mass., U. S.**

LAMB KNITTING MACHINE.—A STRAIGHT MACHINE FOR KNITTING RIBBED FABRICS FOR CARDIGAN JACKETS, ETC.

Report.—Commended for excellency of stitch, simplicity of construction, superior workmanship, and originality.

25. **Dana Bickford, New York, N. Y., U. S.**

CIRCULAR FAMILY KNITTING MACHINE.

Report.—A good circular knitting machine, commended for originality in construction of mechanism for reversing cam-cylinder to enable a circular machine to produce a tubular or a flat fabric.

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26. **Franz & Pope Knitting Machine Co., Bucyrus, Ohio, U. S.**

FAMILY KNITTING MACHINE.

Report.—A good circular knitting machine, commended for originality in the construction of a circular machine which permits the removal of needles, or placing them in position to be gradually moved into or out of action, to produce heels in hosiery fabrics, and to knit gores.

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27. **Campbell & Clute, Cohoes, N. Y., U. S.**

UPRIGHT ROTARY KNITTING MACHINE.—A CIRCULAR KNITTING MACHINE USING BEARDED NEEDLES.

Report.—Commended for excellent attachment to prevent the work running off the needles when the thread breaks, and for a good automatic self-regulating take-up.

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28. **United States Corset Co., New York, N. Y., U. S.**

CORSET-WEAVING POWER LOOM.—A CORSET-WEAVING POWER LOOM, EMPLOYING THE "LYLE" POSITIVE-MOTION SHUTTLE, AND AN IRREGULAR TAKE-UP COMPOSED OF INDIA-RUBBER BANDS AND ROLLERS.

Report.—Commended for excellent quality and quantity of work performed, originality, simplicity of mechanism, and good workmanship.

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29. **Butler Braider Co., Clinton, Mass., U. S.**

BRAIDING MACHINE.

Report.—Commended for simplicity of construction, quality of workmanship, and originality.

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30. **National Needle Co., Springfield, Mass., U. S.**

NEEDLE-MAKING MACHINES AND SEWING-MACHINE NEEDLES.

Report.—(1.) Sewing-machine needles of excellent quality.

(2.) An excellent display of a system and of machines for making sewing-machine needles.

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31. **James Smith & Son, Astwood Bank, near Redditch, England.**

NEEDLES.

Report.—A good assortment of hand and sewing-machine needles.

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32. **H. Millward & Son, Redditch, England.**

NEEDLES.

Report.—The largest assortment of hand and sewing-machine needles.

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33. **Leo. Lammertz, Aix-la-Chapelle, Germany.**

NEEDLES.

Report.—A first-rate display of sewing-machine needles.

34. The Billings & Spencer Co., Hartford, Conn., U. S.

DROP-FORGED AND COLD-PRESSED SEWING-MACHINE SHUTTLES.

Report.—Commended for quality of workmanship and materials.

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35. Kirby, Beard, & Co., Birmingham and Redditch, England.

PINS, AND HAND AND SEWING-MACHINE NEEDLES.

Report.—A fine display of pins and of hand and sewing-machine needles.

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36. Mrs. H. G. Suplee, San Francisco, Cal., U. S.

AN OPEN-EYED NEEDLE WHICH MAY BE THREADED WITHOUT REEVING.

Report.—Commended for its adaptation to the use of persons of defective sight.

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37. Joseph D. Oppenheimer, Philadelphia, Pa., U. S.

A HAIR-CURLING TUBE HEATED BY HOT WATER OR STEAM.

Report.—Commended for originality.

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38. The Pyramid Pin Co., New Haven, Conn., U. S.

PIN-STICKING MACHINE.—A MACHINE FOR STICKING PINS ON A CONTINUOUS STRIP OF PAPER, THE STRIPS BEING SUBSEQUENTLY WOUND INTO CONICAL FORM.

Report.—Commended for quality and quantity of work done, simplicity of parts and motions, and originality.

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39. Albin Warth, Stapleton, N. Y., U. S.

A TRAVELING CLOTH-FOLDING AND MEASURING MACHINE FOR TAILORS' USE.

Report.—Commended for quality and quantity of work performed, quality of workmanship and materials, and originality.

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40. Wilkie & Osborn, Guelph, Canada.

A SEWING-MACHINE TREADLE MADE ADJUSTABLE IN THE ARC OF A CIRCLE TO ADAPT IT TO THE REQUIREMENTS OF DIFFERENT OPERATORS.

Report.—Commended for simplicity and adaptability.

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41. Albin Warth, Stapleton, N. Y., U. S.

CLOTH-CUTTING MACHINE.—A CLOTH-CUTTING MACHINE EMPLOYING A RECIPROCATING CUTTER-BLADE IN A TURNING HEAD AT THE END OF A PIVOTED ARM, GUIDED ON A TRACK OR RAIL AT THE SIDE OF THE TABLE ON WHICH THE CLOTH RESTS.

Report.—A good machine for cutting cloth, commended for accuracy of operation in curved lines and in corners, and for good workmanship and materials.

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42. Isaac Fenno & Co., Boston, Mass., U. S.

A CLOTH-CUTTING MACHINE EMPLOYING A ROTATING CUTTER AT THE END OF A UNIVERSALLY-MOVING ARM.

Report.—A good machine for cutting cloth, commended for great rapidity and ease of operation, and for good workmanship.

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43. Robert Bell Sanson, London, England.

A SPRING-ARM BAND-SAW CLOTH-CUTTING MACHINE.

Report.—Commended for accuracy and speed of work performed.

44. Levi B. Storrs, Canton, N. Y., U. S.

TAILORS' PRESSING MACHINE.

Report.—Commended for simplicity of construction and originality.

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45. John Stark, Waltham, Mass., U. S.

AMERICAN COMBINATION LATHE AND WATCHMAKERS' TOOLS.

Report.—Commended for adaptability to different uses, and quality of workmanship and materials.

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46. Sl. Vautier & Sons, Carouge, Switzerland.

TOOLS FOR WATCHMAKERS AND JEWELERS; FILES, GRAVERS, AND BURNISHERS FOR WATCHMAKING AND JEWELRY.

Report.—Commended for quality of workmanship and materials.

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47. Louis Borel-Petitpierre, Couvet, Neuchâtel, Switzerland.

TOOLS AND INSTRUMENTS FOR WATCH MANUFACTURING.—WATCHMAKERS' LATHES AND MACHINES FOR THE HAND SYSTEM OF WATCHMAKING AND REPAIRING, AND A COMBINATION LATHE WITH SLIDES AND TOOLS.

Report.—Commended for quality of workmanship and materials.

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48. Gimson & Coltman, Leicester, England.

KNITTING MACHINE FOR RIBBED FABRICS.—A CIRCULAR RIBBING MACHINE FOR HEAVY WORK, ADAPTED TO MAKE TUBULAR GOODS WITH POLKA OR PLAIN RIB STITCH; ALSO A KNITTING MACHINE FOR KNITTING RIB TOPS WITH ONE OR MORE COLORS.

Report.—Commended for quantity and quality of work done, quality of workmanship and materials, and originality.

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49. John Wright Smith, Leicester, England.

KNITTING-MACHINE NEEDLES.

Report.—Commended for the best assortment of knitting-machine bearded and latch needles of various sizes, grades, and gauges, and adapted to different machines.

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50. American Watch Company, Waltham, Mass., U. S.

A SYSTEM OF WATCHMAKING.

Report.—Commended for originality, as being the first to adapt the system of assembling interchangeable parts to the manufacture of watches.

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51. American Watch Company, Waltham, Mass., U. S.

WATCHMAKING MACHINERY.

Report.—Commended for quality and quantity of work done, quality of workmanship and materials, originality, and completeness of general display.

SIGNING JUDGES OF GROUP XXII.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

GEO. W. GREGORY, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 28.
E. H. KNIGHT, 18, 19, 23, 24, 25, 26, 27, 29, 30, 33, 34, 39, 41, 42, 43, 46, 47, 48, 50, 51.
F. A. PAGET, 15, 17, 20, 21, 22, 31, 32, 35, 36, 37, 38, 40, 44, 45, 49.

SUPPLEMENT TO GROUP XXII.

REPORTS

OF

JUDGES ON APPEALS.

JUDGES.

JOHN FRITZ, Bethlehem, Pa.
EDWARD CONLEY, Cincinnati, Ohio.
CHARLES STAPLES, JR., Portland, Me.
BENJ. F. BRITTON, New York City.
H. H. SMITH, Philadelphia, Pa.
COLEMAN SELLERS, Philadelphia, Pa.
JAMES L. CLAGHORN, Philadelphia, Pa.
HENRY K. OLIVER, Salem, Mass.
M. WILKINS, Harrisburg, Oregon.
S. F. BAIRD, Washington, D. C.

1. American Watch Tool Co., Waltham, Mass., U. S.

WATCHMAKERS' TOOLS.

Report.—Commended for a very fine display of watchmakers' tools of fine finish, good design and workmanship, and fitness for the use to which they are applicable.

2. Hawley & Branson, Chicago, Ill., U. S.

KNITTING MACHINES.

Report.—Commended for simplicity of construction, good workmanship, and fitness for purpose intended.

3. Wardwell Manufacturing Co., St. Louis, Mo., U. S.

SEWING MACHINE.

Report.—Commended for simplicity and ingenuity, and as evincing progress in lock stitch machines using two spools.

4. Gesswein & Reichhelm, New York, N. Y., U. S.

POLISHING AND FINISHING IMPLEMENTS AND TOOLS FOR JEWELERS.

Report.—Commended for quality and variety of wheels, tools, and brushes for polishing and satin-finishing of jewelry and silver ware.

5. Calvin R. Tuttle, New Brighton, Beaver County, Pa., U. S.

CIRCULAR KNITTING MACHINE.

Report.—Commended as a well-constructed hand-operated circular knitting machine, adapted to be rotated or reciprocated for circular or flat work, and provided with an interior adjustable needle-cylinder, into which some of the needles from the main cylinder may be placed when it is desired to produce a circular fabric having a series of ribs or figures to ornament the stocking.

6. Elizabeth F. Shaw, New York, N. Y., U. S.

SEWING MACHINE DRESS PROTECTOR.

Report.—Commended for fitness for the purposes intended, and adaptation to public wants.

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7. Coles Universal Feed Sewing Machine Co., New York, N. Y., U. S.

SEWING MACHINE.

Report.—Commended for ingenuity and progress in the direction of a combined machine for sewing and embroidery with braid.

SIGNING JUDGES OF SUPPLEMENT TO GROUP XXII.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

COLEMAN SELLERS, 1, 2, 3, 4, 7.
EDWARD H. KNIGHT, 5.
EDWARD CONLEY, 6.

United States Centennial Commission.

INTERNATIONAL EXHIBITION,

1876.

REPORTS AND AWARDS

GROUP XXIII.

EDITED BY

FRANCIS A. WALKER,

CHIEF OF THE BUREAU OF AWARDS.

PHILADELPHIA:

J. B. LIPPINCOTT & CO.

1877.

SYSTEM OF AWARDS

[*Extract from Circular of April* 8, 1876.]

Awards shall be based upon written reports attested by the signatures of their authors.

The Judges will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the Commission of each country and in conformity with the distribution and allotment to each, which will be hereafter announced. The Judges from the United States will be appointed by the Centennial Commission.

* * * * * * * * * * *

Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Each report will be delivered to the Centennial Commission as soon as completed, for final award and publication.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress, and will consist of a diploma with a uniform Bronze Medal, and a special report of the Judges on the subject of the Award.

Each exhibitor will have the right to produce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

ORGANIZATION AND DUTIES OF THE JUDGES.

[*Extract from Circular of May* 1, 1876.]

Two hundred and fifty Judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the Groups to which they have been respectively assigned. The foreign members of this body have been appointed

by the Commission of each country, in conformity with the distribution and allotment to each, adopted by the United States Centennial Commission. The Judges from the United States have been appointed by the Centennial Commission.

To facilitate the examination by the Judges of the articles exhibited, they have been classified in Groups. To each of these Groups a competent number of Judges (Foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the Departments of Agriculture and Horticulture, which will form temporary exhibitions, have been arranged in special Groups, and Judges will be assigned to them hereafter.

The Judges will meet for organization on May 24, at 12 M., at the Judges' Pavilion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

The Judges assigned to each Group will choose from among themselves a Chairman and a Secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a Judge in each Group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed, by a majority of the Judges in such Group.

The reports of the Judges recommending awards based on the standards of merit referred to in the foregoing System of Awards, must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the Judges on the subject of the Award, together with a Diploma and a uniform Bronze Medal.

Upon matters not submitted for competitive trial, and upon such others as may be named by the Commission, the Judges will prepare reports showing the progress made during the past hundred years.

Vacancies in the corps of Judges will be filled by the authority which made the original appointment.

No exhibitor can be a Judge in the Group in which he exhibits.

An exhibitor, who is not the manufacturer or producer of the article exhibited, shall not be entitled to an award.

The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the Judges. Upon request, he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the Commission relating to awards, subject to an appeal to the Commission.

A. T. GOSHORN,
Director-General.

[*Extract from Director-General's Address to Judges, May* 24, 1876.]

"The method of initiating awards which we have adopted differs in some respects from that pursued in previous exhibitions. In place of the anonymous verdict of a jury, we have substituted the written opinion of a Judge. On this basis awards will carry the weight and guarantees due to individual personal character, ability, and attainments, and to this extent their reliability and value will be increased. It is not expected that you will shower awards indiscriminately upon the products in this vast collection. You may possibly find a large proportion in no way raised above the dead level, nor deserving of particular notice. The standard above which particular merit worthy of distinction begins is for you to determine. In this regard I have only to express the desire of the Centennial Commission, that you should do this with absolute freedom, and when you meet with a product which you consider worthy of an award, we desire you to say, in as few words as you may deem suitable, why you think so.

"This, gentlemen, is all we ask of you in the Departments of Awards. Opinions thus expressed will indicate the inherent and comparative merits, qualities, and adaptations of the products,—information which the public most desires.

"Elaborate general reports and voluminous essays, though of great value as sources of general information, give little aid in determining the reliable or intrinsic merits of particular, individual products.

"The regulations which have been published divide the work of awards into three parts:

"1st. The individual work of the Judges.

"2d. The collective work of the groups of Judges.

"3d. The final decisions of the United States Centennial Commission in conformity with the acts of Congress.

"Each award will thus pass three ordeals, which, doubtless, will be ample and satisfactory."

GROUP XXIII.

JUDGES.

AMERICAN.	FOREIGN.
JOHN P. REYNOLDS, Chicago, Ill.	JOHN COLEMAN, Great Britain.
JAMES S. GRINNELL, Greenfield, Mass.	FERMIN ROSILLO, Spain.
JAMES BRUCE, Corvallis, Oregon.	PEDRO D. G. PAES LEME, Brazil.

EKEDA KENZO, E. OLDENDORFF, JOHN BRADFORD, assigned from Group IV, and GEORGE E. WARING, JR., from Group XXVI.

GROUP XXIII.

AGRICULTURAL MACHINES, IMPLEMENTS OF AGRICULTURE, HORTICULTURE, AND GARDENING.

CLASS 670.—TILLAGE.

Manual implements,—spades, hoes, rakes. Animal power machinery,—plows, cultivators, horse-hoes, clod-crushers, rollers, harrows. Steam power machinery,—plows, breakers, harrows, cultivators.

CLASS 671.—PLANTING.

Manual implements,—corn-planters and hand drills. Animal power machinery,—grain and manure drills; corn and cotton planters. Steam power machinery,—grain and manure drills.

CLASS 672.—HARVESTING.

Manual implements,—grain cradles, sickles, reaping hooks. Animal power machinery,—reapers and headers. Mowers, tedders, rakes, hay elevators, and hay loaders. Potato diggers.

CLASS 673.—PREPARATORY TO MARKETING.

Thrashers, clover-hullers, corn-shellers, winnowers, hay-making apparatus.

CLASS 674.—APPLICABLE TO FARM ECONOMY.

Portable and stationary engines, chaffers, hay and feed cutters, slicers, pulpers, corn mills, farm boilers and steamers, incubators. Churns for hand and power, butter-workers, cans and pails, cheese-presses, vats, and apparatus.

CLASS 675.—Dairy fittings and appliances.

CLASS 680.—LAYING OUT AND IMPROVING FARMS.

Clearing, stump-extractors, construction of roads, draining, irrigating apparatus, models of fences, gates, drains, out-falls, dams, embankments, irrigating machinery, stack building and thatching.

CLASS 682.—TRANSPORTATION.

Wagons, carts, sleds, harness. (See also Group XXVII.) Yokes, and apparatus for road making and excavating. (For traction engines, see Group XVIII.)

CLASS 683.—FARM BUILDINGS.

Models and drawings of farm houses and tenements, barns, stables, hop-houses, fruit-driers, ice-houses, wind-mills, granaries, barracks, apiaries, cocooneries, aviaries, abattoirs, and dairies.

GENERAL REPORT

OF THE

JUDGES OF GROUP XXIII.

INTERNATIONAL EXHIBITION,
Philadelphia, December, 1876.

PROF. FRANCIS A. WALKER, *Chief of Bureau of Awards:*

SIR,—I forward you herewith the general report of the Judges of Group XXIII.

Respectfully yours,
JOHN COLEMAN,
Chairman.

GROUP XXIII.

AGRICULTURAL MACHINES, IMPLEMENTS OF AGRICULTURE, HORTICULTURE AND GARDENING.

In presenting this report on awards of agricultural machines, the Judges are desirous of expressing their appreciation of the American and Canadian exhibits, which indicated a highly satisfactory progress. They regret that the English manufacturers did not consider it to their interest to contribute; a comparison between the two greatest exporting countries of the world would have been both interesting and instructive. We have been informed that the reasons assigned by English makers for their absence were, first, that the tariff rendered American business impossible; and, secondly, the heavy expense attending such an exhibition. These reasons are valid enough as far as they go, but the Philadelphia Exhibition drew together peoples of all nations and languages, all eager for information, many anxious to carry back to their distant homes such machinery as seemed most suitable for their respective localities; and as the English makers, by their absence, left the field of enterprise open to the American exhibitors, a considerably increased foreign trade may be looked for as one result of this truly great Centennial gathering. And the development of a foreign trade will prove of great advantage at a time when production has equaled, and in many cases overrun, demand. Hitherto agricultural machinists have had hard work to keep up to the ever-increasing demand (especially in the Western States) for labor-saving machinery, and their ingenuity has been kept on the stretch; but of late years, owing to the undoubted success of the pioneers, many large firms have been established, who manufacture their specialties by the tens of thousands, and, vast as is the country, we have been astonished at the present manufacturing capabilities, and wonder as to where the produce can be profitably got rid of. At such a time, when the home

trade is depressed, the opening out of new markets must prove of great advantage to the manufacturers, and we hope and believe that this may be one result of the enterprise displayed in bringing together such a complete illustration of the agricultural mechanical resources of the United States and Canada. Considering the vast distances of many of the exhibiting countries, it is not surprising that the foreign collection of agricultural implements was small. France, Germany, Austria, Sweden, and Russia were represented, but only to a very limited degree; it would have been highly interesting had circumstances allowed of a more general comparison. But we trust that the result of the Centennial Exhibition will be the dissemination, far and wide, of efficient machinery, without which good cultivation and profitable returns are impossible.

Before entering into particulars as to the different classes of machines, we would notice the absence (almost entire) of either traction engines or machinery for cultivating the land by steam-power. In the American section there was one exhibit of a steam-power digger, in which the engine was attached to the implement, the digging apparatus consisting of a number of spades attached to a revolving shaft, driven from the engine; the locomotion of the machine being effected partly by steam and partly by the resistance of the soil to the diggers. The patentee was not willing to test his invention in the field, and as all such applications have long since been abandoned in England and elsewhere as impracticable and opposed to the first principles of steam-power mechanics, we could not see our way to a report. It is probable that up to the present time, owing to the land being generally light, the superficial nature of cultivating operations, the comparatively low price of horses and mules, a necessity for steam-cultivators has not yet arisen. But the time may come when such a power will be of great value in prairie cultivation.

AVELING & PORTER, *Rochester, England.*

Traction engines, which are a necessary element in steam-cultivating machinery, are as yet but little employed. We noticed, however, with satisfaction the admirable exhibit of this firm, as well as their steam-roller, which might with advantage be made use of for the better construction of roads in this country. We regret that during the thrashing trials at Schenck's, when these engines rendered valuable service in transporting the machinery from the railroad to the scene of operations, so comparatively few witnessed their marvelous performances; all, however, who were present were unanimous

in expressions of satisfaction, both as regards the power and the perfect accuracy and ease with which one man can drive and steer, going in and out in much less space than a wagon and horses, and turning almost in their own area. It does seem to us that such a controllable power would be of great service in the large farms of the West, especially if, as it is confidently believed, they can be utilized for the reaping of grain.

CLASS 670.—TILLAGE.

MANUAL IMPLEMENTS.—Spades, hoes, rakes, etc., were shown by several firms. Ingenious in construction, of excellent material, admirably adapted for their particular uses, and much lower in price than in England; probably owing to both wood and iron being cheaper.

ANIMAL-POWER MACHINERY.—Plows were shown by numerous makers and of varying forms. Those for the Eastern States were of the ordinary type, *i.e.*, without wheels, or with one small wheel at the end of the beam, strong, straight beam with short handles; the mouldboard of great strength, short and abrupt, adapted for rough work, and especially for breaking up rough ground; capable of scouring, *i.e.*, keeping the face clean, even in sticky soils, the object being to break up the furrow as much as possible, not to turn it over in an unbroken condition, which is the perfection of plowing in England. These plows are well adapted for their work, but the draft is considerable.

In the Western States gang-plows and sulky-plows are chiefly used. We have a frame on two large traveling-wheels, with a driver's seat in the centre, the plows, which are double in the former and single in the latter, being suspended by beams from the axle. It is held, and correctly so, that the weight of the driver is counterbalanced by the use of large wheels, and the conversion to a great extent of a sliding for a rolling friction; draft might be further economized if the landside and sole of the plow were replaced by a friction-wheel set at an angle and placed behind the body, as in our modern double-furrow plows; a leverage arrangement allows the driver to raise the plows clear of the ground at the land's end, and also to regulate the depth as the work is in progress. The draft is taken from the beam, the horses being yoked to a pole, and is therefore central.

After the war, these riding-plows came largely into use, owing to the number of maimed plowmen, and during the heat of the struggle hands were at times so scarce that the wives and daughters of the farmers might be seen steering these machines. One of our col-

leagues, Mr. James Bruce, from Carvallos, Oregon, who formerly farmed about 1100 acres, of which 500 acres were arable, assured us that he and his man were able to plow 50 acres a week during the winter season with two gang-plows, each drawn by four mules; this gives over four acres a day for each implement. The occupations being extensive the distance to and from home is often considerable, and it is a great advantage to be able to trot always at the rate of six miles an hour. No opportunity occurred for a trial of plows, but there is no reason to doubt that both the gang- and sulky-plows are capable of doing excellent work.

The Canadians contributed a number of plows, some of excellent design, made very much after the English model, only stronger in the mould-board.

One of the most noticeable of the single-furrow plows was that made by the Acton Plow Company, in which the beam was unusually prolonged, and bent behind the mould-board, securing direct draft. The handles or stilts are very short, and represent nearly the half of a circle. The frame of the plow, of solid wrought-iron, forms part of the beam. In this department we noticed a double and treble furrow-plow, made much like some of ours.

E. Klundth, of Sweden, exhibited six plows, noticeable for construction, quality of material, fairly good finish, and reasonable price. Four of these were designed for the Russian trade, where the soil is generally light and does not clog. These have vertical friction-wheels behind the land-side and projecting three-quarters of an inch below the sole, so that in dry soils the wheel does actually carry the weight. There is also a small wheel behind the mould-board. The Swedish plows have no wheels; the body is cast in one piece with the land-side. The share is of wrought-iron laid with steel, and the beam and handles are in one piece. Another peculiarity which adds to strength is the prolongation of the land-side until it occupies a space between the share and the mould-board. The Göteborg Machine Company also exhibited a large collection of plows from their extensive works, which we understand find employment for 800 men. Most of these have a split beam with strong frame and separate handles; they are not so strong as the last described, but are on a good Scotch model. Owing to the low price of iron and labor, these plows can be bought at home on most reasonable terms.

Cultivators, horse-hoes, etc., of various kinds were shown, some adapted only for single rows with or without expansive apparatus; others, and of these we would more immediately speak, have a double frame, with a driver's seat between large wheels. Such a machine is

specially adapted for cultivating Indian corn, which requires great attention during early growth. We select for description an excellent implement, shown by P. P. Mast & Co., of Springfield, Ohio, which has a movable seat, and can be driven by attendant either walking or riding. Each frame carrying the cultivating tines is hung by a chain from the top of the upright standard. The arm or blade is jointed to the frame, and braced by an iron band, to which a wooden pin is so attached as to render the connection rigid under ordinary pressure. Should the tine or arm come in contact with a stump or fast stone, the pin breaks and the arm, being jointed to the frame, flies back, and thus serious breakage is avoided. This is a clever arrangement, of great utility in land only recently broken. To prevent the corn being cut by the knives, a rotating, toothed wheel attached to an arm which is connected with the frame runs along the surface of the ground. Such a cultivator, placed on 4-feet wheels, runs light and is a very efficient implement; different forms of blades and points can be used, so that if desired the plants can be earthed up after all the weeds are removed. Some farmers object to these machines, on the ground that some corn is injured on the headlands by the horses in turning; they prefer a smaller implement, taking half the interval between the rows at once, completing the space on the return journey; but the great argument in favor of the larger machines is the importance of rapid cultivation for a crop that grows with such amazing rapidity.

Neither American nor Canadian agriculture has as yet adopted steam-culture. Considering the cheapness of fuel and the vast area of many of the farms, together with the flat character of the prairies, this is remarkable. Owing to the superficial character of cultivating operations, the moderate price of horses and mules, and the general prevalence of light land, a necessity for steam-culture has not yet arisen. It is a matter of regret that Americans had not an opportunity of inspecting and seeing the work of English machinery. Traction engines, however, which are as yet but little employed, were shown by Messrs. Aveling & Porter, of Rochester; and those who witnessed the trials of thrashing-machines and portable engines at Schenck's Station were surprised and delighted with their performances. Without their valuable assistance much time must have been lost. In the American section there was one exhibit of a steam-power digger, in which the engine was attached to the implement, the latter consisting of a series of revolving tines or forks. The locomotion of the machine being effected partly by steam and partly by the resistance of the soil to the diggers, the exhibitor was not prepared to test his

invention in the field, where, according to all experience, it would not have succeeded.

CLASS 671.—PLANTING.

Grain-drills were entirely confined to the American section. Here, however, the entries were numerous, and the merit in several instances considerable. We subjected these machines to a severe test, including delivery of grain on the level, the hill-side, and up- and down-hill at gradients which would scarcely occur in practice, but which afforded material for a comparison. The result is given in the tables on pages 10, 11. Each experiment represents one-eighth of an acre, sown at the rate, or near the rate, of two bushels per acre of wheat. Experiments were made with oats and peas. The tables relate to wheat only.

The great *desideratum* in a drill is even distribution of seed, one cup delivering as nearly as possible the same as another, and the whole depositing uniformly in whatever position the drill may be placed. Great variations will be observed in some of the records. We proceed to supply reasons. One of the great modern improvements which is now generally adopted is some kind of appliance to secure a force-feed. There are various ways in which this is secured. The most common is to have a roller on the shaft, either fixed or shifting, which, working in a confined position (the seed-cup), carries a certain quantity of grain round with it for each revolution, and the seed falls away from it into the tubes which conduct it to the ground. These rollers are various as to form and surface corrugations; but the great point of difference as to results depends upon whether the roller fills the seed-cup or only occupies a varying portion according to the quantity of seed to be sown. In the latter case it will be readily understood that when the inclination of the drill causes the seed to fall away from the roller, a less quantity of seed will be sown than either on the level or when the seed accumulates over the roller. We therefore unhesitatingly pronounce in favor of those drills which have a fixed feed-roller occupying the entire space of the seed-cup. Then, again, the quantity of seed to be sown is regulated in two ways, either by change-wheels, causing the seed-spindle to revolve faster or slower, or by opening or closing a slide door in the seed-cups. The latter plan has an apparent advantage, viz., that the regulations can be minute and made while the machine is in operation; whereas, with one exception (Farmers' Friend drill), change of gear-wheels can only be done when the drill is stationary. Nevertheless, we are firmly persuaded that the change of wheels, which is the original plan, is decidedly the more accurate. In confirmation of this we would draw attention to the results of trials with Bickford & Huff-

man's and Ludlow & Rodgers' drills, in which the force-feed and seed-cups are identical. The former regulates delivery by change-wheels, the latter by closing the outlet. The force-feed, which is by no means of the best form, consists of a vertical disk-wheel, occupying one side of the chamber, with numerous small elevations proceeding from the centre to the circumference. In Bickford & Huffman's drill the difference between the discharge from different cups during the trials ranged from 1¼ to 1¾ ounces; whereas in Ludlow & Rodgers' drill the range was from 2¼ to 5½ ounces, a difference so great that we were obliged to withhold our report, although the drill had otherwise many favorable points. We especially notice the force-feed arrangements in the McSherry and Farmers' Friend drills. In the former case the ribs of the wheel are spiral, so that before one rib has finished discharging at one side the next rib has commenced at the other side; thus a regular flow is maintained. A spring-washer attached to this roller prevents the grain being crushed or squeezed against the side of the box. In the Farmers' Friend the force-feed roller is cylindrical, with eight zigzag ribs on its surface, each alternate one running in an opposite direction, being slightly concave. The seed is forced out from both sides of the cup, and a regular, even distribution secured. In both these drills alternation of quantity is effected by change of wheels; but in the Farmers' Friend, by a clever arrangement of a cluster of wheels on a cone, the wheel can be changed by a lever-handle while the machine is in motion. We may notice other salient points of recent improvement common to most of the machines that were exhibited. An arrangement by which the alternate hoes can be set forward seven or eight inches, and thus present a broken line, with more space for the passage of clods, stones, or weeds. This is not a requisite or desirable position when the soil is in a favorable condition, because the closer the hoes are the more will they act as harrows in breaking and pulverizing the surface. A combined leverage, by which raising the hoes out of the ground throws the drill out of gear, and this is such a quick action that not a grain need be wasted. The lower portion of the hoe-frame is hinged, so that in the event of coming in contact with a post, stone, or tree-root, a not unusual accident in many districts, the hoe flies back and accident is avoided. As soon as the obstruction is removed, or rather the machine is set free from the obstruction, the hoe, acted upon by a powerful rubber spring, flies back into its place. This is a very perfect and ingenious arrangement. Then either in front of or behind the seed-box is placed a small seed-distributer, driven from the main wheel by a crank. With this the grass-seeds, clover, and

timothy can be sown at the same time as the grain. The hoes are fixed, and cannot be varied so as to drill the corn at varying widths. This must be considered a disadvantage, and it would be desirable if it could be overcome. We must also notice, as a useful appendix to most of the better machines, a small apparatus for indicating the area traversed during work. This is known as the "Surveyor," and comprises a thread on the seed-spindle, actuating a small-toothed wheel, which drives an indicator on a dial-plate. Without pretending to absolute accuracy, this arrangement gives a close approximation, and is a guide to the operator as to the distribution of his seed, and a telltale for the master as to the servant's industry. For planting pulse crops, the seed-cups that are not required to sow may be closed up. On the whole, we are led to believe that great progress has been made in the manufacture of grain-drills, and that American makers are decidedly ahead in this respect.

Fertilizing attachments are supplied by several firms, enabling the farmer to deposit a small quantity of artificial manure with the grain. We subjected some of these to a trial, first with dry and then with damp superphosphate of lime, but the quality of the manure was so poor that it did not allow of a sufficiently severe test to prove efficiency. We do not consider these attachments of much value. It is very seldom that regularity of delivery is possible. Manures, such as Peruvian guano and good phosphate, have a tendency to work into a pasty condition, which renders it impossible to secure even delivery, and it is by no means a proved fact that applying the manure with grain is desirable. Ammoniacal mixtures have, especially in a dry climate, a marked tendency to check germination. Again, in light land, there is danger that some portion of the manure may be washed away before the crop is ready to absorb it. Of the machines that came to trial, Bickford & Huffman's made the best work. This has a series of star-shaped revolving scrapers, working close to the bottom of the box, with cutting edges and slightly concave surfaces, and bringing the manure over the parts which are regulated by a sliding bottom, which determines the quantity delivered. Instead of depositing the fertilizer with the grain, we should prefer its being sown broadcast over the surface when the plants had developed root, —thus, in the case of winter wheat, just at the time when spring growth commences. In the case of spring corn, the application may be made when the plants are about a month old. Not only will the rootlets spring out in search of the manure, but the manure being distributed on the surface, and not buried, the soil will be less likely to be washed down.

EXPERIMENTS.

D. E. McSherry & Co., *Dayton, Ohio.**

Total		Maximum.		Minimum.		Variation.	Variation per Acre from Level.
Lbs.	Oz	Lbs	Oz	Lbs.	Oz.	Lbs. Oz	Lbs. Oz.
16	4½	2	1¼	2	0	1	....
16	3¼	2	1	2	0	1	— 10
16	3	2	1	2	0	1	— 19
14	6¼	1	13¾	1	11½	2½	— 14 14
17	11¾	2	6	2	2¼	3¾	+ 11 10

)hio.†

15	6½	1	15¼	1	13¼	2	....
15	6	1	15½	1	13½	2	— 4
15	6¼	1	15¾	1	13¾	2	+ 2
13	5¾	1	11¼	1	10	1¼	— 16 6
16	5½	2	1¾	1	15¼	2½	+ 7 8

‡

16	3	2	1	1	15½	1½	....
14	8½	1	13¾	1	12½	1	— 13 4
17	4¼	2	3	2	2	1	+ 8 10
13	12¼	1	12¼	1	10½	1¾	— 19 6
18	14	2	7¾	2	4½	3¼	+ 21 8

own, Md.‖

14	4¼	1	15½	1	9¼	6¼	....
13	11½	2	0¼	1	8½	7¾	— 3 14
13	7¼	1	15¾	1	8¼	7	— 4 4
13	12¾	1	15	1	9¾	5¼	— 3 12
14	0⅛	2	0	1	9¾	6¼	— 1 14

* Recommended as accurate.
§ No report, on account of irregularity on hill-sides.

† Recommended as accurate.
‖ No report, on account of great irregularity between experiments.

‡ No report, as too great variations on hill-side.

EXPERIMENTS—*Continued.*

Thomas, Ludlow, & Rodgers—Superior Drill.*

	1	2	3	4	5	6	7	Minimum.	Range.	Variation per Acre from Level.
	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.
On level	1 9¾	1 12	1 11½	1 13	1 11¼		1 12½	1 9¾	3¼	....
Right-hand elevation	1 10	1 11¼	1 10½	1 11	1 10		1 10⅝	1 9	2¾	— 5 6
Left-hand elevation	1 11¼	1 13¾	1 12¾	1 12¾	1 11¼		1 11	1 9½	3¾	— 10
Down-hill	1 7⅝	1 10	1 9½	1 11¼	1 10¼		1 12¼	1 7¾	5⅝	— 4 4
Up-hill	1 11	1 13¾	1 13	1 14¾	1 12½		1 13¼	1 11	3¾	+ 5

Johnston, Gear, & Truman.†

	1	2	3	4	5	6	7	8	9	10	Total.	Maximum.	Minimum	Range.	Variation from Level.
	Lbs. Oz.	Lbs. Oz.	Lbs. Oz	Lbs. Oz	Lbs. Oz	Lbs. Oz.	Lbs. Oz.	Lbs. Oz	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz	Lbs. Oz.	Lbs. Oz	Lbs. Oz.
On level	1 10¼	1 10⅛	1 10¼	1 10½	1 10¾	1 10¾	1 9⅝	1 9¼	1 9¾	....	14 12	1 10¾	1 9½	1¼	....
Right-hand elevation	1 10¾	1 11	1 10¾	1 10¼	1 11¾	1 10¼	1 10	1 10½	1 10¼	....	15 0½	1 11¾	1 10	1¾	+ 2 4
Left-hand elevation	1 9¼	1 10	1 9½	1 9¼	1 10	1 9¼	1 9	1 9¼	1 9¼	....	14 5¾	1 10	1 9	1	— 3 2
Down-hill	1 8¼	1 8½	1 8	1 8½	1 8½	1 8	1 7½	1 7¼	1 8	....	13 9	1 8½	1 7½	1	— 0 8
Up-hill	1 12¾	1 12½	1 12½	1 12½	1 12¼	1 11¾	1 11½	1 11¼	1 11¾	....	15 13¼	1 12¾	1 11½	1¼	+ 8 10

H. L. & C. P. Brown—The Empire Grain Drill, *Shortsville, N. Y.*‡

	1	2	3	4	5	6	7	8	9	10	Total.	Maximum.	Minimum	Range.	Variation from Level.
On level	1 7¾	1 8¼	1 8½	1 9	1 8½	1 7¾	1 7½	1 7⅝	1 6½	1 7¾	14 15¼	1 9	1 6½	2½	....
Right-hand elevation	1 7¾	1 8¼	1 8½	1 9	1 8¾	1 7½	1 7¾	1 8	1 6¾	1 8	15 0¼	1 9	1 6½	2¼	— 0 8
Left-hand elevation	1 9	1 9½	1 10	1 10¾	1 10½	1 9¼	1 9½	1 9¼	1 8½	1 9¾	16 0¼	1 10¾	1 8½	2¼	+ 8 8
Down-hill	1 6¼	1 7	1 6¾	1 7⅛	1 7⅛	1 6¼	1 6¼	1 6¾	1 6	1 7	14 12¼	1 7½	1 6	1½	— 1 8
Up-hill	1 12¾	1 13¼	1 13¼	1 14	1 14	1 13⅝	1 13⅝	1 13¾	1 12¾	1 13¾	18 8¼	1 14	1 12¾	1¼	+28 8

Bickford & Huffman, *Macedon, N. Y.*§

	1	2	3	4	5	6	7	8	9	10	Total.	Maximum.	Minimum	Range.	Variation from Level.
On level	1 13	1 13	1 12½	1 12¾	1 12¼	1 13¼	1 13½	1 13½	1 14	1 12¾		1 14	1 12¾	1¾	....
Right-hand elevation	1 12¾	1 13	1 12¾	1 12¼	1 12¼	1 13½	1 13	1 13	1 13¼	1 12¾		1 13½	1 12¾	1 ¾	— 1 8
Left-hand elevation	1 13½	1 13¾	1 13	1 13	1 13¾	1 13¾	1 13¾	1 13¼	1 14¾	1 13¾		1 14¾	1 13	1¾	+ 2 2
Down-hill	1 12¼	1 12¼	1 12¾	1 12¾	1 11¾	1 12¼	1 12¾	1 12½	1 13½	1 13¾		1 13½	1 11¼	1¾	—30
Up-hill	1 14¼	1 14¼	1 14	1 13¾	1 13¾	1 13¾	1 14½	1 14¾	1 15	1 13¾	18 13¾	1 15	1 13¼	1¾	+ 5 2

* No report, on account of irregularity between cups.
‡ No report, on account of great differences.
† Recommended for regular discharge of contents in all positions.
§ Recommended for regularity of delivery under all conditions.

Corn-planters, *i.e.*, machines for planting Indian corn, were both numerous and of ingenious construction. The original inventor was Mr. George Brown, of Galesburg, Illinois, whose planter still holds its place as a well-made and efficient machine. The importance of the corn crop, especially in the Western States, is so great that it is natural that much attention should be devoted to these implements. The object of the farmer is to plant the corn in lines about four feet apart each way, putting three or four grains into each spot, not huddled together but somewhat scattered. Accuracy of work, so that the lines intersect at right angles, is very important, as allowing of more perfect cultivation during growth, on which, and the previous preparation of the land, the result greatly depends. When the surface is made ready for the seed, that is, reduced to a fine condition, the ground is marked out by running the planter across the field empty; a marker consisting of a lever-arm with a shifting pointer indicates the line for the wheel-track on the return journey. Great care is exercised to commence planting at exactly right angles to the cross-lines. The machines which are commonly used consist of a jointed frame supported on broad wheels; across the frame and immediately in front of the wheels are the two seed-boxes. The driver's seat is in the centre, between and somewhat behind the wheels, his weight acting as a balance. Immediately in front of him and between the seed-boxes is the seat for the boy, who sits crossways, so as to work the lever-handle in connection with the dropper, which regulates the discharge of seed at the proper intervals. In front of the runner is a coulter, which opens the ground for the reception of the seed, and in the case of the Keystone corn-planter, manufactured at Sterling, Illinois, this shoe is adjustable. The corn is dropped from the rear of the runner in view of the driver, who can thus see that the action is complete. In the best machines the corn is first deposited in a lower chamber; the distance from this to the ground is small, and the action of the valve causes the corn to be ejected with a side and backward motion, which insures it being scattered in the hill. More or less seed can be sown as required. The frame carrying the seed-boxes, etc., can be raised clear of the ground by foot-leverage, for turning at the land's end and for traveling. In some machines the surface of the wheels is concave, which causes a slight elevation to be made by their track. In this way the grain can be planted with great accuracy, and the crop has a very symmetrical appearance and can be dealt with to great advantage in the subsequent tillage operations. An attempt has been made to make the action automatic, and so save the work of the boy as well as the marking out.

HAWORTH PLANTER COMPANY, *London, Ohio.*

An invention whereby the desired result is obtained by means of a rope made fast at both ends of the field; this rope, which has knots at the requisite intervals, passes over and around pulleys on the planter; the action of the knots causes the grain-dropping apparatus to come into operation. We believe this invention, which we did not see at work, is thought highly of. The price, $30, which includes a quarter of a mile of rope, does not appear extravagant.

JOSEPH ROTHSCHILD, *Shelbyville, Ky.*

An invention which admits of much improvement in detail, but is sufficiently ingenious to merit a short notice. The dimensions of the traveling-wheels set out beyond the seed-boxes are such that each half revolution causes the cam to actuate the dropper at suitable intervals. Two spring disks on each wheel mark the spot where the corn is deposited, and act as track-markers. The wheels have a series of spikes on their surfaces. If the wheel-disks on the return journey are not in a line with the holes made before, and consequently the seeding is out of line, then the attendant, by lowering or raising the wheel, for which suitable machinery is provided, causes ground to be gained or lost, as required; of course a marker is used to indicate the line to be traversed. This is a highly ingenious arrangement, and likely to become, when perfect, of great use.

Several single-horse planters, taking one row at a time, were shown, the dropping apparatus identical with those already described, variable as to the quantity of seed and the distance between the drills. Such machines are suitable for small occupations, being more expeditious and cheaper than the ordinary system of planting by hand, which hitherto has been principally followed in the Eastern States. It should be stated that the dropping apparatus is so excellent in the best corn-planters that the variation in delivery seldom exceeds one grain; three or four are generally deposited.

CLASS 672.—HARVESTING.

There is no description of manufacturing enterprise in connection with agricultural machines that has been more successful, or made more gigantic strides in a comparatively short period, than that of reaping and mowing machinery. In the history of many of our most valuable inventions the originators have had neither credit nor commercial advantage from their inventions. Jethro Tull, the father of drill-husbandry, was an object of ridicule to his neighbors, and it was

left for a more enlightened posterity to do honor to the man who raised agriculture from a rude art into a scientific process. The earlier thrashing-machines in England were smashed by an ignorant peasantry, who imagined that because the business was expedited they would be thrown out of employment. How different has been the fortune of the man, still among us, who first produced a practical reaping-machine, and whose exhibits at the Centennial proved that he has not been idle since 1851, when he first astonished the agricultural mind by his exhibits at the Exhibition in London! It is still, we believe, a disputed question whether McCormick, of Chicago, or the Rev. Mr. Bell, of Scotland, was the original inventor. We are inclined to divide the honors. The fact that to Mr. Bell was awarded a medal by the Highland Agricultural Society of Scotland, in 1823, seems to show that he was in reality the first inventor, but to McCormick belongs the equal honor of first producing a machine that could be practically made use of. Our Chairman remembers contemplating the frail-looking and somewhat cumbrous machine in the Exhibition. In order to obtain a just idea of the progress that has been made, a walk through Agricultural Hall, and a visit to the trial-fields at Eddington and Schenck's, would convince the most skeptical as to present proficiency and the large interests now involved in the trade. We are almost afraid to quote figures, they appear so marvelous, but McCormick, of Chicago, Illinois, alone turns out 12,000 machines per annum. The three firms engaged in the manufacture of the Champion reaping- and mowing-machines are stated to produce 30,000 a year. The Buckeye is also made in large quantities. F. L. Osborne's manufactory is one of the largest in the States. Mr. Walter A. Wood produces largely at Hoosac Falls, and numbers of smaller houses are doing a good business. Considering that a great proportion are made for the home trade only, it is a matter of surprise that the market has not been long since glutted. We have no doubt that, as in trade generally, production has overtaken demand, and it is to be hoped that one effect of the Centennial Exhibition will be an increased foreign trade. With the exception of Canada, and one exhibit from Australia and Russia, the vast array of harvesting machinery was of American manufacture.

The Judges take this opportunity of expressing their satisfaction at the alteration of the programme, which substituted comparative for competitive trials, a modification which they believe was equally approved by a large majority of the exhibitors. The value of competitive trials depends upon their being thoroughly exhaustive, to which end a crop difficult to cut, machinery of a special character for test-

ing, a large area of land, and plenty of time to apply the tests, are indispensable requisites. At Eddington the crop was light and open, affording no criterion as to the behavior of the machine under difficulties. It is true that by rolling down the grass the cutting was rendered more difficult, but this did not exactly represent natural difficulties. Through the courtesy of an exhibitor we were able to apply a test as to draft, particulars of which are given below. In the wheat-field again a light, upstanding, and very unripe crop did not show the capabilities of the reaping-machines for picking up a laid, tangled, and heavy crop. Moreover, with so much merit, it would have been a very responsible and difficult business to select the best machine, and it would have been hard upon others, whose machines differed only in some trifling and unimportant detail, to be left out without recognition or report. As it was, the trials were of use to the Judges, in enabling them to frame their reports; interesting to the public, as proved by the large attendance; and satisfactory to the exhibitors, who had an opportunity of displaying their goods to the best advantage.

The trial of mowing-machines, hay-tedders, horse-rakes, hay-loaders and unloaders, took place at Eddington, June 27, 28, and 29, under the direction of Captain Landreth and Mr. Geddes, to whom we desire to express our acknowledgments for their courtesy and attention on this and all other occasions.

Twenty-two machines were exhibited, all but two being tested on the dynamometer. This important business was undertaken by Messrs. Oldendorff and Bruce, the following valuable table being the result of their labors:

No.	Exhibitor.	Distance Run.	Rear or Front Cut.	Height of Cut.	Width of Cut.	Total Draft.	Draft per Square Foot of Grass Cut.
		Feet.		Inches.	Ft. Ins.	Pounds.	
1	Warder, Mitchell, & Co.	100	Rear.	1½	3 9¾	131	.343
2	Russell & Co. (Peerless)	"	"	1½	4 4	157	.388
3	Rochester Agricultural Works.	"	"	1½	4 6¾	206	.392
4	C. W. Otis (Haymaker)	"	Front.	1½	4 3	165	.388
5	Eureka Company	"	"	1¾	5 11½	172	.288
6	Adriance, Platt, & Co.	"	"	1½	4 3	200	.470
7	C. Aultman & Co.	"	"	1½	4 4½	178	.406
8	W. A. Wood	"	"	1½	4 4	222½	.513
9	Bradley Manufacturing Comp'y.	"	"	1½	4 3	182½	.429
10	Johnston & Co.	"	Rear.	1½	4 2½	204	.484
11	W. Farr Goodwin	"	Front.	1½	4 3	186	.437
12	Osborne & Co.	"	Rear.	1½	4 7¼	260	.564
13	The Screw Mower Company	"	Front.	1½	4 2¾	235	.555
14	Keystone Mower Company	"	Rear.	1½	4 5¾	228	.509
15	McCormick	"	"	1½	4 0¾	190	.467
16	Grigg & Co.	"	Front.	1⅝	4 7	205	.446
17	Osborne & Co.	"	"	1½	4 3¾	220	.510
18	Osborne & Co.	"	"	1½	4 11¾	238	.471
19	Hubbard (Meadow Lock)	"	Rear.	1½	4 0	140	.350
20	Aultman, Miller, & Co.	"	"	1½	4 0	171	.427

It will be seen from the above that the draft per square foot of grass cut varied from .288, in the case of the Eureka machine (direct draft), to .564 in one of Osborne's machines, or nearly 100 per cent. In reality the difference was not quite so great, inasmuch as the Eureka cut a quarter of an inch higher; but, allowing for this, we still have the fact that this machine was the lightest of all that were tried, and, as it is on a totally different principle from the original models, a short reference to its leading features may not be out of place.

The Eureka is a direct-draft mower,—that is to say, the knife works in front of and between the wheels, and the horses are attached to the centre of the machine, equidistant between the wheels, and are so placed, by means of a long neck-yoke, that while one walks on the uncut grass, clear of the knife, the other walks where the track-board has cleared the cut grass, thus the mowed grass is not interfered with, an important point as regards curing. The wheels are much larger than in ordinary machines. The cutter-bar, which in the machine tested was six feet long, is placed in front of the wheels. The pitman works at right angles with the knife, the connection between the two being a bell-crank lever. It might be thought that the horses treading down the grass would prevent even cutting, but this is not so; did the machine follow the tracks instead of meeting them, we cannot say how it would be, but one great advantage of this form of machine is that it returns along the same line, and therefore meets the grass that has been trodden down. Every crop can be dealt with according to its particular form; thus, supposing the grass beaten down in any direction, the machine can be driven at right angles to the lie, and thus good cutting is secured. By a peculiar method of attaching the knife-bar to the frame flexibility is acquired, and we could not see that any machine cut the standing grass more evenly; at any rate, the cutting was sufficiently good. One great merit in this machine is that, owing to having a clearer track on both sides, the cut grass is laid up in a beautifully light, open swathe, very favorable for curing. Indeed, in fair weather very little after-work is required. Two horses worked a six-foot cutter with ease. The gearing is simple, no bevel-wheels are used, and we do not see why such a machine should not wear well, and there can be no question that as a mower it is a highly valuable implement. The Eureka is made by the Towanda Eureka Mower Company, Towanda, Pennsylvania. Another departure from the ordinary form is seen in the Haymaker mower, made by Otis Brothers & Co., of New York, in which the motion is transmitted from the traveling-wheels to the knife by a single pair of bevel-

wheels, thereby effecting a saving of power by a considerable reduction of friction. Though simple enough in reality, the mechanism by which this is effected is somewhat difficult to describe. We find a small bevel-wheel, with forty-six teeth, fixed to the axle, and a similar wheel in all respects, only having two more teeth, gearing into it, but being hung in a gimbal-joint like a ship's compass, it does not revolve, but makes a succession of rapid serpentine vibrations around the face of the other wheel, and an arm extended from the vibrating disk down to the knife gives it the required reciprocating motion. The motion is remarkably pretty; and as six or eight teeth are always engaged at once, instead of two or three, as in ordinary gearing, the wear is more evenly distributed. There is only one rotating bearing besides the axle, viz., that of a simple fly-wheel, which tends to give regularity and steadiness of motion. The only point that is likely to wear is the gimbal-joint, and this we may safely put against the boxes and bearings of ordinary machines. It is noiseless in running, and the work done on upstanding grass is excellent. Because there was no flexible cutting-bar—which could be easily applied—the rolled grass was not cut well. The knife has plenty of speed, viz., 23 revolutions, or 46 cuts for each revolution of the wheel. We venture to express our opinion highly favorable to the merits of this machine, which, it will be seen, stood well for lightness of draft. The simplicity of the machine, and consequent lightness, must not be overlooked in points of merit. There were two other novelties exhibited, both, we believe, the invention of Mr. W. Farr Goodwin, of Stelton, New Jersey; the older machine, shown by the Screw Mower Company, of Philipsburg, New Jersey, has the ordinary gearing replaced by a large gun-metal screw-wheel on the axle, working into a worm on the crank-shaft. The screw-wheel works in oil, the cover being a receptacle. This is sufficient to condemn the principle. Farmers and their servants are too careless for such details; either the machine would be put away without the oil being removed, or it would be omitted when at work, and then great damage would be done in a short time. Moreover, this machine, though it cut the grass well, was heavy in draft. Mr. Wm. Farr Goodwin's more recent invention is certainly ingenious. In the reciprocating screw mowing-machine there is neither gear nor cog-wheel, crank-wheel nor revolving journal, save the main axle, on which is arranged the peculiar mechanical contrivance for converting rotary into reciprocating motion, which is by means of a reciprocating screw on the nut-and-bolt principle. The power is thus applied very directly, but the friction on the surfaces of the screw-wheels must be considerable, since the record is not good, and a pair

of strong horses did not appear to like their job. We do not think, moreover, that the knife travels with sufficient velocity to effect all kinds of cutting. Of the ordinarily constructed machines, the Peerless, made by C. Russell & Co., of Canton, Ohio, and the Champion machines, made by the Champion Machine Company, of Springfield, Ohio, by Warder, Mitchell, & Co., of Springfield, Ohio, and by Whiteley, Fassler, & Kelley, of Springfield, Ohio, made the cleanest and best work, and appear well-made, serviceable machines. We also approve of the mower shown by the Rochester Agricultural Works, of Rochester, New York, and by James L. Spink & Co., of Minneapolis, Minnesota, its manufacturers, as simple in construction and light in draft. The heavier draft machines—those of the Johnston Harvester Company, of Brockport, New York, the different forms of the Buckeye machine, shown by Adriance, Platt, & Co., of New York, N. Y., and by Aultman, Miller, & Co., of Akron, Ohio—made a creditable performance, and the same may be said of McCormick's mower. The W. A. Wood, of Hoosac Falls, New York, cut well when the crop was upright, but owing to its not having a flexible cutter-bar, was useless in the rolled grass. Our conclusion was that the mowing-machine and combined machine business has reached a high state of perfection in the United States, and that farmers may well be puzzled to know which to select where many are so good. Too much stress must not be laid upon draft alone. It is quite true that it is of great importance. If, as in the Eureka, a six-foot cut can be made as easily as a four-foot cut, we have at once a saving of one-third of our horse-power; but all the ordinary machines are well within the compass of two horses, and, after all, the difference in the better machines is not very great. Although not brought to trial, we cannot pass over without special commendation the mowing-machine and combined mower and reaper shown by L. D. Sawyer & Co., of Hamilton, Ontario, Canada, which appears to have much merit. The inside driving-wheel is made larger by one inch diameter than the outside, in order to obviate side draft. The ordinary clutch-gear, for throwing in and out, is replaced by an eccentric. The knife-bar is suspended on the drag-bar in such a manner that the position of the knife-bar is secured. The ratchet-gear on both driving-wheels is without springs. The combined machine shown by the same firm is also a very practical machine, with an ingenious arrangement for hinging back the platform so as to reduce the width of the machine for passing through farm gateways.

Hay-tedders and horse-rakes do not call for any special notice. Certain awards were made, but the Judges were not impressed with

the merit of these machines, and in some instances the construction appeared defective. There was only one hay-loader exhibited, that of Messrs. Stratton & Cullum, of Meadsville, Pennsylvania (known as Faust's hay-loader), but so successful in its operation and so saving of labor that a short reference is indispensable. This is a thoroughly practical machine, readily attached to any ordinary farm-wagon, and capable of taking the hay out of windrow quite as closely and as rapidly as could be done by four men; the proof of this is the fact that it requires two men in the wagon to load the hay as delivered. The machine comprises a revolving spindle (on high wheels) and forked tines, somewhat resembling an English tedder, which picks up the hay and delivers it to an elevator of simple construction with a wind-quad. The action is continuous and perfect, all that is necessary is that the windrow be carefully made; but this can be made by a horse-rake, so that manual labor is reduced to a minimum. Equally effective are the unloading forks and conveyers, by which the hay is elevated from the wagon by horse-power, and conveyed to any portion of the barn or mow desired. In this way two men on the wagon, one attending to the fork, and two hands in the barn, are capable of stacking as much hay as could be pitched by four able-bodied men. We notice and record great progress in this department of farm economy. Until the horse is accustomed to work the fork, a boy in attendance is necessary, but after a little education the intelligence of the animal enables it to perform the operations by word of mouth from the man working the fork. There are several forms of this implement: thus we have the single- and double-shaft harpoon, and the expanding forks, differing in utility but all having commendable efficiency. We see no reason why the loader should not be used for hoisting loose grain, although such operations are necessarily wasteful, and only to be resorted to when it is impossible to tie up the grain.

The great feature of the Exhibition, as regards reaping machinery, was the practical realization of a long-wanted and much-desired combination of a cutting- and automatic binding-machine. It would be premature and injudicious to say that the present will be the ultimate form, or that the arrangements are perfect. Much improvement is desirable, so as to simplify the mechanism; but just as the first Exhibition was memorable for the introduction of a reaping-machine, will this be remembered as the first public occasion upon which automatic binders were successfully worked. There were four separate inventions shown, and all were practically tested at Schenck's, three of them successfully, while the ingenious invention of Mr. McPherson

failed more from bad workmanship than from defective construction; indeed, it appears to us to possess elements of great merit, and we trust to see it eventually successful. The other exhibitors were F. D. Osborne, to whom must be awarded special commendation, since his machine never once stopped, nor failed to deliver a well-bound sheaf, McCormick, and W. A. Wood. In all the material used for tying is iron wire, and the *modus operandi*, though arrived at by different mechanical means, is identical. To the ordinary harvester, which cuts the grain and carries it, by means of a revolving table and elevator, to the tying platform, is applied the tying apparatus, which consists of a revolving lever that places the wire around the grain, while an ingenious arrangement of toothed wheels working in a rack twists and cuts the wire, which receives the requisite amount of tension in the process. The sheaf thus made is either allowed to fall from the table by the pressure of freshly-formed sheaves behind or is ejected by a spring action. As a rule, the wire was well tied, and sufficiently tight for ripe grain; how far wire will answer when the grain is cut before fully ripe we had no means of testing, as, unfortunately, the crop at Schenck's was quite ten days over-ripe, and considering the tangled condition of the heads in consequence, it was creditable that such a good separation was made. To the unfavorable condition of the crop must to some degree be attributed the failure of the South Australian reaping- and thrashing-machine, which is thus spoken of in Mr. William Harcus' work on that colony: "The greatest invention ever produced for the agriculturists of South Australia is Ridley's reaping-machine, which reaps and thrashes the wheat by one simple process." We were very anxious to see this novelty at work, and Mr. Davenport, the energetic Commissioner, took the greatest possible trouble in the matter. Unfortunately, whether from the over-ripe condition of the crop, or the way in which the heads hung down, the comb-like collectors clogged up, only a portion of the ears were removed, and at every few yards the machine had to be stopped. The idea is to take off the heads at the junction with the straw, pass them into a box, and act upon them with a drum with four beaters, driven at a very high speed. This separates the grain from the chaff, and blows the products into the receptacle behind. At the land's end it is emptied into sheets and winnowed at once for market. It is clear that either this machine is capable of much improvement or it should be abandoned in favor of a simpler arrangement.

The varying requirements of different districts were well illustrated by the exhibition at Schenck's, which embraced all sorts except the

heading-machine, which we believe is principally confined to California, Oregon, and such districts. 1st, we had specimens of the harvester reapers, which we believe have commanded a large sale in some of the Western States. With one exception, to be alluded to, the old plan of a revolving platform, which travels at right angles to the forward motion, is adopted. This is either of cloth furnished with half-round wooden laths at intervals, or is made of wooden shakers with iron pins. The grain is thus led to the elevators, and either carried up between two traveling-cloths, as in McCormick's machine, or on the outside, its falling back being prevented by a guard; two men occupy the tying platform, in some instances standing or sitting close together, when they get in each other's way, in others being separated as widely as the nature of the work allows. As fast as the sheaves are made they are either thrown off or placed on a tipped platform actuated by a leverage from the driver's foot, who drops ten sheaves at a time.

A novel and, as it appears to us, advantageous divergence from this type was shown by Messrs. George Esterly & Son, of Whitewater, Wisconsin, and known as the Esterly harvester. Unfortunately, this machine was not taken to Schenck's, but we think there can be no question as to its being capable of successful working. The knife is driven in the same way as sweep-rake reapers, and not by an attachment in the centre of the blade with connecting-rod passing under the platform,—a clumsy arrangement, liable to become impeded by dirt, etc., but rendered necessary in the ordinary form. The platform is fixed, comprising first a level surface, and then a slightly-concave elevation, up which the grain is swept at required intervals by a balanced rake, which works quite independently and in a different orbit from the reel, which, however, derives its motion by chain-gearing from it, and can be regulated up or down, backward or forward, to suit the requirements of the crop. The advantage is in the quieter movement of the grain, which is liable, if ripe, to be knocked out by the revolving platform. But the especially meritorious feature of the Esterly machine is in the traveler on the binding platform, which is so arranged as to collect the grain brought by the rake and convey it first to one binder and then to the other, the binders being seated at opposite sides of the platform. Not only are they out of each other's way and able to employ their labor efficiently, but the traveler does some of the work by compressing the grain into the form of a sheaf. We think it possible for two men, thus assisted, to tie up a light crop of moderate length, and to do quite as much work as five or even six men could with the gavels, as made by the

ordinary sweep-rake reaper. We see no reason why the traveler might not be replaced by an automatic binder.

2d. The table-rake reapers were exhibited by Mr. W. A. Wood, of Hoosac Falls, New York, and C. Aultman & Co., of Canton, Ohio. The first machine, in which the rake is attached to a chain-gear which travels around the outside of a nearly square platform, was not a success, as the grain was laid too much to the rear of the machine, and not clear of the horses' track during the next journey. Messrs. Aultman's apparatus, in which the jointed rake is driven by universal joint- and bevel-gearing, being directed in its orbit by a common table screened from the grain by a shield, made excellent work, and offers some advantages over ordinary sweep-rakes, especially in the superior form of the gavel for binding. The rake can be worked continuously or stopped at any portion of its course by leverage from the driver's foot, thereby allowing of regulating the size of the gavels according to the crop. The disadvantages of the table-rake appear to be that as the rake compresses the grain at the corner of the table there would be some risk of the grain shedding when over-ripe, while the closeness of the gavel interferes with the drying influence of sun and wind when the corn is cut green. The practical farmer alone can decide in which direction the balance lies according to his requirements.

3d. By far the largest number of machines exhibited at the Exhibition and worked at Schenck's were on the sweep-rake principle, with improved turn-table adjustment, which we believe was first patented by the Johnston Harvester Company, of Brockport, New York, and which enables the operator to convert rakes into collectors and collectors into rakes to suit the varying conditions of the crop; in other words, any or all of the arms can be made to rake off the grain, so that for every revolution of the rakes one, two, three, or four sheaves can be made, and this action in nearly all of the machines can be made automatic or controllable. Without going into details we may state that most of these machines cut and laid well, and represent a very decided advance on their originals.

CLASS 673.—Machines Preparatory to Marketing.

Thrashers.—As was to be expected, this was a large entry, confined, however, almost entirely to the American section; Canada exhibiting three or four machines and Russia one. The latter, a powerful but cumbrous-looking implement, was built somewhat on the English plan, while the Canadian exhibits were on the American model. In the few remarks that are called for we shall therefore confine our attention to the home production. Though steam- and horse-power

thrashers were invented and brought into use long before harvesting implements, similar progress is not visible. The thrashing-machine of to-day is undoubtedly much improved and combines more operations than the original, which was merely a revolving drum or cylinder and an inclined open platform. The produce, after being acted upon by the drum, fell into this open platform, when it was shaken up by manual labor, the chaff and the grain passing through the openings of the platform with much short-straw cavings, etc., while the longer straw was carried away from the lower end of the platform, being first well shaken by men with forks. At the present day we find the American machines of two distinct types. In the older form, the produce, after passing the cylinder, is carried by an inclined revolving cloth, furnished with cross sections or cups of wood, a distance of about ten feet. Then the thrashed corn, chaff, and such ears as have passed the cylinder entire or only partially thrashed, fall upon the shaker, which has a reciprocating motion. The grain and chaff passing through the openings of the shaker-screen, meet the blast from the winnower, the chaff is blown right out of the machine, while the grain passes to the sack by means of a spout, assisted in some cases by a revolving screw. The unthrashed heads, etc., which for distinction may be called *cavings*, passing over the end of the screen, are conducted by a spout to the hopper of the elevator, carried back to the drum, and rethrashed. The straw is passed from the carrier on the straw-belt, being aided thereto by the picker, a revolving triangular piece of wood. The straw-belt is agitated so as to carry the straw a distance of five or six feet by a series of jerks; any loose grain carried over with the straw is thus shaken free, and, falling through the open spaces of the belt, is conducted back to the screen. In most of these machines both the cylinder and concave are close,—*i.e.*, their surfaces are covered with sheet-iron.

In more modern forms the cloth-carrier is replaced by shaker-frames and reciprocating forks. The cylinder and concave are both open, so that a large proportion of the chaff and grain falls at once on to an inclined plane, by which it reaches the screen of the winnower. Any grain passed forward with the straw is shaken out during its forward passage, and finds its way by another inclined board back to the winnower. We think this is a step in the right direction, reducing the work which the machine has to do, and bringing the grain more rapidly to the winnower. It must be bad economy to carry all the grain a distance of ten feet when it might be got rid of at once. The special merit claimed for the American cylinder is the rapidity with which it thrashes; its weakness, that it cannot thrash clean at one

operation, and hence a portion of the produce is always on its way back to the cylinder to be thrashed over again. Depending entirely for cleaning operations upon one fan, which, as a rule, is driven from the cylinder-shaft, it stands to reason that with all due care the wind must be irregular, owing to the fact that the speed of the cylinder is checked whenever an extra quantity of feed is presented. We ought to state that in one machine, made by the Geiser Company, an attempt is made to obviate this defect by providing self-adjusting shuttles, which are regulated by the force of wind striking on and actuating a counter-balance; whether this action is quick enough to be effective we cannot say. The cylinder, which is a modification of the old Scotch peg drum, breaks the straw very much, which we believe is not considered a disadvantage for litter purposes, but rather the reverse; it certainly increases the difficulty of handling. Considering the additional labor that is necessary to produce No. 1 grain for the market, it is a question whether, on the whole, machines similar to the improved English model would not prove the more economical; certainly their use is attended with less scattering and loss of grain. It is probable that less grain would be thrashed, but the great bulk of the grain would be ready for market, and worth more from the polishing up to which it is twice subjected by at least twenty-five cents a quarter. It is probable that short and headed grain would thrash fastest by an American cylinder, but given a good, fair crop, we do not think the difference would be sufficient to make up for these manifest deficiencies.

The straw-elevators to convey from the machine to the wagon are simple and inexpensive, answer well in still weather, but are useless in a cross wind, as the sides are low and there is no sort of cover or guard. Field-trials were organized at Schenck's Station, the forty-six acres of wheat cut by the reaping-machines being reserved for this purpose. These trials were in progress from the 17th to the 22d of July inclusive, but, owing probably to their not being competitive, only a portion of the exhibits were presented, and of the nine machines which were tried only three were adapted for steam-power; the remainder were two-horse and one-horse machines, to be driven by railway-power. An attempt (which occupied two days) was made to test the power consumed by running each machine through a friction dynamometer, but, owing to the pulleys being too small, no reliable results could be obtained, and this part of the programme was abandoned with much regret, as it is an important point to determine the relative draft of each machine. The following table represents the results obtained:

NAME.	PRICE.	WEIGHT OF GRAIN. POUNDS.	TIME OCCUPIED. MINUTES.	WEIGHT OF GRAIN THRASHED. POUNDS.	SEC'D.	WASTE UNDER MACHINE.	REMARKS.
G. Westinghouse & Co. 10 horse-power.	....	2000	15½	638	......	30	Tail taken with waste. This machine made good work, and appears thoroughly well made and useful.
Geiser & Co.	....	2000	16	630½	......	15½	This machine took a large amount of power, owing to complication of gearing, without adequate results. Self-adjusting wind-space.
Pennsylvania Agricultural Works. (A. B. Farquhar.) Cylinder, 30 × 18.	....	2000	14½	598	......	22½	Great vibration. Thrashing not clean.
G. Westinghouse & Co. 2 horse-power. Cylinder, 30 × 14.	....	1000	19½	297½	......	14½	Thrashes fairly clean, and makes good work. A useful machine.
Doylestown Fr. 2 horse-power. Cylinder, 30 × 14. ...	$485	1000	14.58	305	......	35½	Did not thrash clean. Horse-power noisy. Price, complete, $485. Machine .... $225 Horse-power .... 150 Wheels & carriage... 110 $485
Wheeler & Mellick Company. 2 horse-power. ...	515	1000	19	397½	......	22½	Ran steady, and made fair work. Machine .... $235 Power .... 180 Wheels & carriages. 100 $515
Minard Harder. 2 horse-power.	540	1000	18½	320	8½	15½	Good machine, and fair horse-power. Change of gearing to either side of machine. Good winnowing apparatus. Machine .... $235 Horse-power .... 190 Wheels, etc. 115 $540
Ellis, Hoffman, & Co. (Champion). 1 horse-power. Cylinder, 18 × 17. ...	250	1000	34	319½	......	7	Peculiar arrangement of double fan on shaft of cylinder. Winnows by double spouts to air-chamber. Fans make a good *duster*. No elevator to bring back cavings which collected from under machine and rethrashed. Six men employed. Power too small to be economical. Machine .... $150 Horse-power 100 $250
Heebner & Sons. Cylinder, 20½ × 16.	315	1000	15.15	305	......	30	Overshot concave, and no duster. Very trying for feeder. Tread-power has some good features. Large level track for horses. Governor on fly-wheel. Large pulley-wheels. Made fair work. Machine .... $140 Power .... 175 $315 No wheels supplied.

We cannot speak very favorably of these small power-machines; they are probably suited to small occupations when the opportunity does not occur to hire steam-thrashers, and it may be that having the machinery at hand and always ready allows of the filling up of odd time which might otherwise be wasted. It is evident that much consideration has been bestowed on the improvement of railway-powers, and much as we dislike to see horses employed on a treadmill, there can be no question that considerably more duty is obtained than through horizontal horse-gears, when the driving-wheel is sufficiently large and the bearings are also large. The pace of tread not exceeding one and a half miles per hour, and if the elevation of the horse-track does not exceed fourteen or fifteen degrees, then such powers are valuable for various kinds of work, and are not necessarily horse-killers, as they have been called.

We have recommended for award such as appear to fulfill the above conditions. We must notice John A. Hafner's patent Eureka coil spring, for thrashing-machines driven by gear. In the Western States eight or ten horses are frequently employed, the power being communicated from the horse-wheel to the thrasher by tumbling-shaft and cog-wheels. It stands to reason that in starting the horses, or whenever the cylinder is choked down from over-feeding and the velocity suddenly checked, a great shock will be experienced both in the running parts and the horses' shoulders, destructive to the machinery and injurious to the animal-power. Again, the shaft of the horse-power is necessarily irregular, and its full force, less friction, cannot be conveyed to the thrasher, unless we have some means of storing and accumulating the power, and this we get by this spring. It consists of a cylindrical coil of three plates made of the best cast spring steel. These plates are riveted together at the inner hook end. The strain on the outer plate, which is thickest, is tensile, while the strain on the inner plates is compressive, and the spring is thus self-supporting and durable. It is contained in a box, which is fitted on to the driving-gear of the thrashing-machine. It is stated by the inventor that a spring fitted up for a ten horse-power will stand and vibrate under a concussion of over one hundred horse-pressure, and, having a length of five feet, will vibrate from the slightest pressure. This spring can be used on all machines, whether worked by horses or steam, or driven by gear or belt, but its peculiar value is for horse-power machines driven by gearing. We saw it applied to a horse-gear belonging to the Pennsylvania Agricultural Works Company, to drive a five horse-power thrasher. The relief to the horses and the steadier running of the machine were apparent and considerable. It would have been better if the

spring had been applied to the spar-wheel which drives the cylinder pinion, but this was, under the circumstances, impossible. Mr. Hafner casts his spring-box upon the spar-wheel, the outer end of the spring being connected with the casing while the inner end connects with the centre hub, which is keyed fast to the shaft, the box being allowed to play fully on the hub.

LILPOP, RAU, & LOEVENSTEIN, *Warsaw, Russia.*

This exhibit, which was tried at Schenck's, is a powerfully-built machine, probably requiring a nominal eight horse-power engine to drive it. The construction is on the English model, the drum being open, with a series of smooth beaters. The concave also has open spaces between the bars. The winnowing and cleaning capacity is large. The corn, however, is only winnowed once, and the straw-shakers have not a sufficiently rapid or independent motion to deliver the straw freely. This machine was tried under considerable disadvantages, as the attendants were not qualified to manage it properly. We are of the opinion that it is well adapted for bad roads and districts where repairs would be difficult to execute.

In our examination of machinery for separating cotton from its seed and preparing it for the manufacture, as well as in the case of coffee-hullers, rice-mills, etc., we had the valuable assistance of Colonel Bradford, whose practical knowledge of the subject was of the greatest importance in helping us to form a correct conclusion. We found seven cotton-gins, all in the American section, and which, although required in the Southern States, were all manufactured in the eastern and northern localities. We think that self-feeders are a most desirable addition, and, considering the danger and risk of accidents, they should be more generally applied than is the case at present. Two different forms of self-feeders were exhibited. The original and probably the best is the invention of S. Z. Hall, of New London, Connecticut, which comprises a large hopper, into which the cotton is thrown with a fork. The bottom of this hopper consists of four revolving wooden rollers, slightly inclining towards the front, with spaces between, which allow dirt, etc., to escape; from the hopper the cotton is caught up by a wooden roller with numerous small spiked teeth, and carried between it and a fine-meshed wire frame, which allows of a further separating of dust, etc. The cotton drops from the rollers into the cutters. In Brown's feeder, which is also made at New London, the only difference is that the bottom of the hopper has a series of fixed and movable bars with iron serrated

teeth, which possibly carry forward the cotton with much regularity. We are also satisfied of the value of the condenser attachment, and highly approve of the arrangement as seen in E. Remington & Sons, of Ilion, New York, Needle cotton-gin, in which the condenser consists of a large lower cylinder covered with perforated zinc and a small close roller above. The cotton passing between is properly condensed, and dust, etc., passes through the openings in the cylinder and is collected in a tube below. Another feature of Remington's machine, from which it derives its name, is the substitution of needles for serrated surfaces in the cutters. The ordinary cotton-gins have, according to size, a certain number of finely-serrated saws on a shaft, revolving between ribs either square or flanged. These ribs support the cotton while it is being torn to pieces by the cutters; the seed passing away, while the cotton finds its way between the saw and the rib into the revolving brush. In Remington's machine the needles are made in sections, of best steel wire, with rounded surfaces, and covered on each side with Babbit metal. The needles neither tear nor saw off the cotton, but pull it out, consequently they preserve the film, and the seed is well cleaned. The ribs are peculiar, having a flange in the centre on the upper surface, which has the effect of keeping the cotton over the needles. The Babbit metal does not heat, so there is not the risk of accidents from that source, which we believe have occurred with the ordinary saw.

DAVID KAHNWEILER, *New York, N. Y.*

The only exhibitor of cotton-seed hullers, showing different sizes of machines, all excellently well made, and suitable for the purpose. One of those to which we particularly wish to draw attention is designed for plantation use, with a view to meet a very desirable improvement, viz., to remove the shell preparatory to the seed being used as cattle-feed. It will be readily conceived that there are conditions under which the sale of the seed for the purpose of oil-manufacture would not answer, owing to expense of transit, etc. Its value as food will be greatly increased if loose cotton and shell can be removed, and not only so, but it will be converted from a highly dangerous into a perfectly safe material for cattle. First of all we have a hopper, with a revolving feed-roller, cast in small sections, which allows the seed to pass into the mill, but keeps out nails or sticks. The mill comprises an under roller, with smooth surface, carrying eight knife sections, placed in different positions, so as to act like a screw. This roller works against a concave with four knives. The shell and seed fall on a fine reciprocating screen, and are kept well distributed thereon

by means of a revolving spindle, furnished with wooden teeth. The seeds pass through the screen, the shell works off. The method of adjusting the knives on the roller is simple and efficient. This machine can be made either for hand or power.

TAPPEY & STEEL, *Petersburg, Va.*

Several cotton-baling presses were shown. Of these, we consider the Beasley power press made by this firm deserving of commendation, both for the pressure brought to bear and for the simplicity of mechanism. The press is put into work by a clutch, and a self-tripping screw throws it out of gear when the pressure has been exerted.

R. WAKEMAN, *Port Deposit, Md.*

A hand-power machine, with admirable leverage, in which the press is raised by ratchet worked by lever, and the pulley lets down by its own weight. A power of fourteen tons can be applied to each lever. In its present form this press is most suitable for hay, but it can be readily altered to suit cotton.

E. J. MORRIS & CO., *Philadelphia, Pa.*

There were very few coffee-hullers on exhibition, and not of great merit. The machinery shown by this house, and especially designed for the large Uraqua berries of Liberia, though doubtlessly accomplishing its object, is at present too diffuse and clumsy a form to justify consideration.

ALBION COFFEE-HULLER COMPANY, *New York, N. Y.*

The more shapely machine of this company, which has elastic pads, did not make at all a good show, and appeared too slow in action.

DANIEL LOMBARD, *New York, N. Y.*

Quite a good hand-machine coffee-huller, which consists of a vertical fluted roller. The coffee passing in at the top is carried round between this and spring-jacketed concave plates, securing the requisite pressure, but allowing of sufficient elasticity to suit the varying size of the berries. The same exhibitor showed a powerful rice mortar and scourer, which can also be used for coffee-hulling. This is a very simple machine, comprising a large oval iron pot, set up on a strong frame, with a revolving spindle through the centre, driven by bevel-gear from below and furnished with a powerful spiral screw. The pot is filled with the seed and the screw driven at 130 revolutions per minute. The shape of the pot insures the seed coming in contact

with the screw. Power machines can scour 30,000 pounds of rice a day.

GEORGE H. PEABODY, *New York, N. Y.*

We were much impressed with the value of a composition of emery attached to wood, which has been discovered and perfected by Mr. Peabody, as an admirable material for the interior surface of rice-shellers. This emery composition is one-eighth of an inch thick, and the attachment to the wood is apparently very durable. Mr. Peabody's inventions with this material include a rice-huller and polisher, for family use; rough-looking machines.

R. H. ALLEN & CO., *New York, N. Y.*

While on this subject, we may notice the only machine in the Exhibition which attempts to economize the labor of corn-husking by substituting mechanical for hand labor. This is the Phillips Spiral corn-husker, shown by R. H. Allen & Co., which appeared an ingenious labor-saving machine, and should come into extensive use. It consists of a frame, across one end and near the top of which are placed two picking-rolls, with spiral grooves, between which the stalks are fed, and in passing through their rolls the stalks are separated from the ears. The stalks drop upon an elevator and are removed. The ears, as they are severed from the stalks, drop upon the husking-rolls, placed lower down in the frame, at right angles to the picking-rolls and in an inclined position. These rollers have grooves corresponding to spikes on the opposite rollers. The spaces are also valuable in allowing the ears to settle down between the rollers, so that the hold upon the husks may be made certain; the spikes are arranged spirally upon the rollers, and hold the husks at one end of the ear and continue the grasp to the opposite end, making the process of stripping the husk from the ear very similar to husking by hand. As the ears slide down the rolls the husks are caught by the steel spikes, drawn in between the rolls, torn off, and dropped upon the elevator, while the ears pass on to the end of the rollers, and are then delivered into a basket. It will be understood that the ears are discharged at the opposite end of the machine from the stalks and husks. A machine costing $150 is capable of husking twenty-five to fifty bushels per hour.

There were a number of corn-shellers, both for hand and power; the former were principally without feeding apparatus, necessitating the constant attention of the operator; most of them were also with-

out fans, requiring the further operation of separating the chaff from the corn. These appear to us defects which should be remedied.

SANDWICH MANUFACTURING COMPANY, *Sandwich, Ill.*

A large exhibit of power-machines, showing three sizes, viz., four-horse, two-horse, and one-horse shellers, which for efficiency of design and excellence of construction were far superior to any other machines. We have endeavored to describe these in our recommendations for award, but consider them worthy of more detailed notice. In the first place, there is in the large machines an excellent feed-elevator, consisting of four rubber straps with convex projections working between three bars, which insure the corn, however carelessly placed on the elevator, being properly straightened and regularly passed into the mill by means of a force-feed spindle furnished with iron flanges. Next the corn is caught by four vertical disk wheels, 7 inches diameter, covered with small teeth, and revolving 600 times a minute. These are known as little pickers. It is passed from them to two large picker-wheels, also vertical, and having teeth on both faces, which, with the aid of steel springs, hold the corn while the bevel-runners, 12 inches diameter, with coarse ribs radiating from the centre, making 700 revolutions per minute, strip the corn from the cob. The latter is thrown out on to a wire elevator, which is in two parts; the farther, at a lower elevation, allows of any corn that may be carried along with the corn being carried back. The corn falls on a riddle, is winnowed, and is elevated either into sacks or a wagon, as is required. The four horse-power machine, which we have endeavored to describe, shells one hundred and fifty bushels per hour. It is admirably made, the strength of each part being properly proportioned.

WINNOWERS.—In the French and German sections revolving cylindered graders were represented, both for grading corn by means of different-sized sections, and also for removing cockles, etc.; the latter being accomplished by an ingenious construction of the internal surface of the cylinder, which is covered with indentations of such size as to hold the cockles, etc., when passing a screen or diaphragm placed across the centre of the cylinder. The cockle-seed falls out of the cells into a central channel, and is conveyed to the outlet by a revolving screw. This makes a very complete separation. The French machines, shown by M. Pernollet, Paris, were separators and graders only. The German, exhibited by Mayer & Co., Kalk, near Cologne, combined a winnower with the separator, but had not the good finish

or completeness of the French machines. The American retains the old form of winnowing-machine, combining in the best specimens very efficient separators. We particularly call attention to W. Cortrites and the Queen of the Harvest, shown by the Queen of the Harvest Company, of West Chazy, Clinton County, New York, as remarkable graders and seed separators.

CLASS 674.—MACHINERY APPLICABLE TO FARM ECONOMY.

PORTABLE AND STATIONARY ENGINES.—A portion of these, being in Machinery Hall, were examined and reported upon by the engineer Judges. One of these only, that of Messrs. Frick & Co., of Waynesborough, Pennsylvania, was sent to Schenck's for trial, and on that only have we reported. We are indebted to Colonel Waring for great assistance in making our examinations, and to his brother, Mr. John B. Waring, aided by Mr. Bryan Danby, Superintendent of Machinery, for conducting the experiments at Schenck's on the 19th, 20th, 21st, and 22d July. These tests were applied with a view to obtain a comparative rather than a positive test, neither time nor opportunity allowing of more than this. One of the Baker blowers, made by T. Wilbraham & Bros., of Philadelphia, was used as the testing power, each engine being employed to drive it having a given quantity of coal and wood. The quantity of water consumed, the time of the experiment, the pressure of the steam, revolutions of the blower, and force exerted, as indicated by a mercury pressure-gauge, were all carefully noted, and formed the elements of comparison. Some description of the more noticeable machines will be appended. The trials were confined to American engines, with one exception,—that of a portable engine with vertical boiler, from Warsaw. Our opinion is that the makers of portable farm engines have principally aimed at the production of a machine that is easy of transportation and reasonable in price, without much regard to the question of duty for fuel consumed,—in other words, the boiler and fire-box capacity are insufficient to produce the most economical results, as the consumption of fuel under such conditions is necessarily wasteful. Doubtless practical experience has led to this arrangement, but it is a question whether more attention should not be paid to the economy of fuel, especially in those districts where fuel is expensive. Inasmuch as most of the work of portable engines takes place during winter, we think it would be desirable that the cylinders and boilers should be felted and lagged; the additional outlay would, in many cases, be well repaid. We suggest for the consideration of makers the question of straw-burning engines for the Western States; we believe that in many districts the

straw, both of grain and corn, is of no value, either as bedding or fodder; it is burnt on the ground as the readiest means of getting rid of a nuisance, and had much better be used as fuel. Portable engines have been made which successfully accomplish this, and in the case of one English firm (Messrs. Ransomes, Sims, & Head, of Ipswich), an arrangement exists for a self-feeder, which delivers the straw into the fire-box in a continuous stream.

Another point worth attention is whether it would not be possible to introduce a light traction engine, sufficiently strong to do the hauling, and possibly the reaping, as such work will assuredly be eventually done by steam-power, and capable of being utilized for steam cultivation, when the time for such work arrives. One great advantage which manufacturers possess here is the superior quality of the best iron, which allows of much less material being used. We believe that such a machine might be made without any really serious increase of weight, and if the same could be bought at not more than fifty per cent. increase over the price of an ordinary portable engine, the advantage in the saving of horse-labor, and expediting operations, would amply repay for the additional outlay. The English machines, admirably well made as they undoubtedly are, are both heavy and costly; equal strength might be obtained with much less weight, especially if steel was used for the fire-box and boiler.

FRICK & Co., *Waynesborough, Pa.*

The Eclipse engine, exhibited by this firm, gave the best results of any that were tested, and is a strong, well-made, and useful machine; the traveling-wheels are large and powerful; the boiler is suspended on springs for traveling, which are let down when at work; it is capacious, having 33 2-in. tubes 6 feet long; there is a good brake on the hind wheels, very useful for staying the engine when at work. The engine is carried on the top of the boiler, resting on a powerful bed-plate, hollowed out to receive and collect waste oil. This can be detached from the brackets and converted into a fixed horizontal engine if desired. The governor has three speeds, and the crank-shaft is counter-balanced; all journals are self-oiling; the engine-saddle has provision for varying expansion; the water-heater is large, of the ordinary diaphragm form; and the pump, with air-chamber, has a double valve, returning excess of water to the supply. The cylinder has balance slide-valves; the safety-valve works by a spring, which is a good arrangement, particularly when the roads are rough; a driving-wheel is provided on each side of the crank-shaft.

Best Steam-Engine and Boiler Works, *Lancaster, Pa.*

A useful farmer's engine, with some specially commendable features; thus the pillar-blocks are on one saddle, which is bolted on the inside to the bed-plate; the feed-water pipe of the pump passes through the pillar-block journals, and thus tends to prevent heating; the pump-rod is well situated, being very direct; a double valve, while it shuts water from the boiler, opens a vent, which allows the water to pass to the ash-pan. There is a simple arrangement for reversing the eccentric without link; the connecting-rod has solid ends. The boxes are set up by key, adjusted by set-screws; the water-heater consists of a long, narrow tube, with a coil of paper inside; steam passes through the centre. This engine made a good record at the trial.

Mansfield Machine Works, *Mansfield, Ohio.*

These works showed in Agricultural Hall a good serviceable-looking engine, which did not come out for trial, and therefore we have no facts for our guidance, but, as far as can be judged from the size of the boiler, and the general construction, it ought to give a good account of itself on the brake. The pump, of good pattern, is driven by eccentric to the main shaft; the position of the engine at the side of the boiler is convenient for getting at. It is carried on a strong, well-arranged bed-plate, which can be detached from its brackets and serve as a stationary horizontal engine. The cylinder is steam-jacketed, and the steam-pipe is lagged; the joints, scraped or ground, avoid the use of packing; it has an adjustable cut-off sliding and throttle-valve, readily fixed at any desired point, balance steam-valve, steel friction, and flue shut. There is a small water-heater, with return-pipes; the crank axle is furnished with a box-spring.

Chandler & Taylor, *Indianapolis, Ind.*

A well-made, light-running engine; the boiler space is hardly proportioned to the engine, consequently the record is not so good as in some other cases. A peculiar arrangement exists for the passage of the steam from the dome, by a pipe passing into and through the boiler to the smoke-box, where the pipe coils so that the steam becomes superheated, and enters the chest in a dry condition; this is an ingenious device to overcome a difficulty, from the fact that the engine is reversed from the ordinary position, and has the cylinder close to the smoke-box. The cylinder is jacketed with felt, and the steam-cylinder is placed below, instead of above, or on the level with the cylinder; the advantage is that whatever condensation takes place

is clear of the cylinder. The piston-valve is balanced, the guides having large surfaces. The pumps have a thin way-valve; there is a spring-seat for the driver, who has within reach the lever-rod, acting on a powerful brake on the hind wheels.

BLYMYER MANUFACTURING COMPANY, *Cincinnati, Ohio.*

The only fixed engine which came under our notice was, strictly speaking, hardly agricultural, being designed to drive sugar machinery. This was the engine shown by the Blymyer Manufacturing Company, and is a strong, well-proportioned engine, with steam-chest and cylinder properly covered; the speed is regulated by cut-off from the governor, instead of the ordinary throttle-valve; this is done by means of a valuable eccentric; the bed-plate very solid, and the water-heater capacious.

LILPOP, RAU, & LOEVENSTEIN, *Warsaw, Russia.*

This firm have, we believe, an extensive manufactory of various kinds of machinery. The engine which they exhibited, and which was carefully tested at Schenck's, is very strongly made, and the frame contains a great deal more iron than would be thought necessary in this country. The explanation given for this is, that the machine is designed for a country where the roads are bad and mechanics scarce; it is certainly not conveniently arranged; thus, the boiler, which is vertical, is carried on the frame, immediately over the front wheels. The cylinder of the engine, which is in an inclined position, is put as far as it is possible to be from the fire-box, consequently the engineer has quite a journey to perform between the two. We fail to see why the engine could not have been placed in a vertical position close to the boiler; there was no governor, and the pump was old-fashioned and very defective; on several occasions the engine had to be stopped, and once the fire raked out from this cause. The boiler, which is of considerable diameter, contains fifty-two pipes, ten of which are smaller than the rest; these pipes hang down from a dome, and the whole is so arranged that a large heating surface is secured. On trial, steam was raised in at least one-third less time than in any other engine, and the result was satisfactory, this engine taking second place for duty.

CHAFFERS, HAY- AND FEED-CUTTERS, SLICERS, AND PULPERS.—We were not impressed with the exhibits under the above heads. In the United States, especially in the large corn-growing districts of the West, but little appears to be done in the way of food preparation.

Straw is not at present of much value—rather an incumbrance to be got rid of than otherwise. Of the few chaffing-machines exhibited, we liked those of the Silver & Deming Manufacturing Company of Salem, Ohio, in which is a good safety arrangement in the event of stones or iron getting into the feed. The fly-wheel continues to revolve, but the knives stop, preventing breakage. This is effected by a friction cone on the shaft. The arrangement for altering the size of cut by shifting a cluster of gear-wheels is simple and efficient. The upper feed-roller is held in place by a spring, and rises according to the pressure of the feed by means of toothed gearing and racks. This is attached to both sides, so that the roller is always parallel. The lower roller is smooth, the upper ribbed; this does not give the self-feeding power of double-fluted rollers. Canada took a decided lead in chaff-cutting machinery.

JOHN WATSON, *Ayr, Ontario, Canada.*

Good power-machines, the knives being attached to the fly-wheel; they cut six sizes of chaff. The same firm exhibited a combined pea-cleaner and pneumatic chaff-conveyer (Tolten's patent), a highly ingenious device, by which the peas are separated from the straw and pods; the latter are cut into chaff and winnowed at the same time; the blast being utilized to convey the chaff up a spout, while the peas are delivered into a hopper below.

In the Pneumatic Chaff-Cutter, also shown by Mr. Watson, the fly-wheel, on which are the knives, is boxed off, and carries four wooden blades, which generate sufficient draft to blow the chaff through a tube for a considerable distance; the air enters under the box and below the knives. The defect in this machine is that the gear-clutch is on the outside of the box, on the right-hand side, and quite beyond the reach of the feeder in case of accident. There is also no reverse action and no protection. The first-described machine is in most respects superior.

DAVID MAXWELL, *Paris, Ontario, Canada.*

A power chaff-cutter with patent gearing, which can reverse, stop, and change the length of cut without the use of a clutch-lever or change of wheels; this is effected by an ingenious cluster of wheels on the lever axle.

A. ANDERSON, *London, Ontario, Canada.*

A capital hand-cutter, without wheel or gearing; the blade is diagonal with ragged edges; the length of cut is regulated by a feed-

board working in a slot, a rubber tension-spring steadies the cut. For simplicity, efficiency, and reasonable cost, this invention is worthy of high praise. Mr. Anderson also showed a hay-knife and bread-cutter with similar edge.

The only exhibits of slicers and pulpers for preparing turnips and mangolds for animal food were shown by John Watson, of Ayr, Ontario, Canada, who deserves great credit for the large and thoroughly useful assortment of machinery which he displayed.

The Triple-action Pulper, Ribbon Cutter, and Slicer, is a valuable adjustment, comprising two disks revolving on the same shaft, one furnished with pulping-blades, the other with slicing- and ribbon-knives. The hopper is in two parts, with a hinged plate to cover over either portion as desired. The pulping-knives can be brought forward or back so as to regulate the size of the pulp.

The Gardener's Slicer and Cutter is an improvement on an old English patent; it has a sliding division-plate or hopper, which insures the roots being continuously presented to the cutting surface.

CORN-MILLS.—There was a considerable collection of stone and metal mills, the latter generally very meritorious, on account of the material used and the efficiency of operation. The most common forms were vertical disks, but there were several instances of conical mills.

SEDGEBEER & MILLER, *Painesville, Ohio.*

The Farmer's feed-mill, shown by this house, is a thoroughly useful mill. It consists of vertical disks covered with Y-shaped projections in alternate circles, ground down with emery to a fine surface. First of all is a small breaker and crusher, consisting of sections on the shaft; next a series of large teeth on the inner section. The mill works equally well in either direction.

W. L. BOYER & BROTHER, *Philadelphia, Pa.*

Good metal mills of conical form. The surfaces both of the mill and the concave are fluted. The edges sharpen themselves by contact; in one machine a bolting-screen is attached. By a clever arrangement the same jigger from the wheel acts on the hopper above and the screen under. The mill is easily adjusted at the ends by set-screws. The feeder's shaft has a cob-breaker, so that corn-meal can be produced without the necessity of shelling the corn. Mr. Watson

also showed a corn-mill with vertical plates with the striations on the grinding surface. The feed is delivered at the centre by a screw. This is a small mill, capable of producing ten bushels an hour when driven by four horses. In a grain-crusher, by the same firm, comprising two revolving fluted rollers, a steel spring between the boxes prevents contact of the rollers when the mill is empty.

JOACKS & BEHRENS, *Lubeck, Germany.*

A model of a millstone with their patent aspirator; a highly valuable invention for securing a current of air between the stones and removing all moisture. The air enters from above, passes through the centre and is exhausted; the flour is forced out on the opposite side by an endless screw with a valve-mouth, so that no air may enter save by the aspirator. The flour is prevented from passing the exhauster by a number of triangular-shaped surfaces of flannel, which hang down all around and present surfaces for the flour to fall against. The case or cover in which the mill is placed consists of wood, felt, and tin inside, and being non-conducting, prevents moisture condensing, a point of great importance. Automatically the flour-catcher is vibrated, and the accumulations of flour fall down and are conveyed to the screw.

DU VIVIER & CO.

In the Aubien bolting mill-stones of this firm, the lower stone has spaces from the circumference to the centre, occupied with metal bolting-sieves, which are agitated by knockers. Bran passes through the opening between the stones, and flour is collected below. In the French department there were several exhibits of burr-stones of fine quality.

INCUBATORS.—Two exhibits of these deserve mention.

S. A. DAY & CO., *Baltimore, Md.*

This incubator is automatic and highly ingenious; the heat, which is supplied from a coal-oil lamp, passes into a hot-air chamber; the cold air enters by holes. Above the hot-air chamber is a supply of water, so as to secure by its evaporation the necessary moisture. The eggs are placed in boxes on sawdust, and the hot air circulates over them. The automatic arrangements are effected by the unequal expansion of a bar composed of rubber and tin. The machine is set for a temperature of 103°, which is found by experience to be most

favorable for incubation; as temperature rises the bar moves by expansion of the rubber, and acts on a leverage, which is fixed so as to connect with the lamp and shut off a portion of the flame. By another adjustment the expansion or contraction of the bar is made to act on a watch-spring, which rings a bell. Thus, if the lamp goes out in the night, or gives out too much heat, in either case the bell is rung and the attendant aroused; this is remarkably clever, and we see no reason why with proper management it should not prove successful.

A simpler scheme was that shown by

A. CORBETT, *Hicksville, Long Island, N. Y.*

The inventor makes use of horse manure as his heating material, both for his incubator and artificial mother; he uses a circular box, in which the eggs are placed in sieves, ventilation being supplied at the top; these boxes are surrounded by stable manure, and a temperature varying from 103° to 110° is thus maintained. In the second box for rearing, the artificial mother consists of a round board, fitting the box, covered on the under side with long wool. The board is attached to a vertical rod fitted with a screw, so as to allow of its being brought nearer to or farther from the bottom according to the size of the chickens.

DAIRY FITTINGS AND APPLIANCES, CHURNS, BUTTER-WORKERS, ETC. —Considering the important interests which have of late years been developed in connection with the manufacture of dairy produce, we were surprised and disappointed not to find a more complete exemplification of the factory system, by which the progress in this direction could be traced. Still, enough exists to show that skill and capital have been largely and profitably developed, and there can, we think, be no question that the change of practice with regard to the manufacture, both of cheese and butter, from the individual producer to the co-operative association, has, under favorable conditions as to supply, proven both economical and convenient,—economical on account of the introduction of labor-saving apparatus, greatly reducing the cost, and convenient as relieving the female portion of the farmer's household of an irksome drudgery. To the United States belongs the credit of first introducing the factory system, as regards cheese-making; while Sweden took the lead in the same method of dealing with butter. England has recently been endeavoring to follow in the footsteps of American enterprise, and the Derby cheese-factories have achieved an encouraging success.

It would have been satisfactory to the Judges if they could have seen the machinery exhibited in actual operation.

H. H. ROE & Co., *Madison, Ohio.*

This was the only complete exhibit of cheese-making apparatus, and comprised a small steam-engine and horizontal boiler, of suitable capacity for factory use. As far as we could judge from examination the latter is of economical construction, and the former of sufficient power for running the largest churn. Next we have two large cheese-vats, of parallelogram form. The vats, made of strong block-tin, rest in wooden cases, with sufficient space under and on all sides for the necessary supply of water, which is heated by means of steam-pipes, with numerous outlets, so distributed over the bottoms of the case as to insure uniform temperature rapidly acquired. This appears a good arrangement, which we believe is generally adopted in the factories. The whey is removed by a siphon. The same firm also exhibited two cheese-vats, with heating apparatus attached; a less costly arrangement, but of very inferior utility, for two reasons: first, the fire raises the temperature of the cheese-room more than is desirable; and, secondly, the fire-space being in the centre only, the water is not so evenly heated as by the introduction of steam.

CARL ATTERLING, *Orebro, Sweden.*

The only other exhibitor of cheese-making apparatus, his design being very similar to that employed in England for the Cheddar system; in this steam is used as the heating medium. It comprises a steam generator, of economical construction, which can be placed in an adjoining room if desired; a small steam-pipe conducts to the steam-jacket of a circular cheese-vat, of large dimensions, composed of copper tinned over; the whey is removed by a stop-cock at the bottom of the vat. In Sweden we found a series of well-executed designs of cheese- and butter-factories, from the well-known dairy engineer, William Rehnstrom. It would have been interesting and instructive if models or plans of some of the leading American factories had been exhibited.

W. O. CAMPBELL & Co., *Richford, Vt.*

In regard to the butter business, we found some excellent arrangement of milk-pans, especially the exhibits of this company in the Dairy Building; a series of large block-tin pans, of rectangular form and divided into unequal compartments, to suit the requirements of the dairy at different seasons. These are contained in zinc or

galvanized troughs, with water-space all round; an adjustable vent regulates the height of the water, an ingenious and useful appliance.

GEO. PLUMB, *North Bangor, N. Y.*

A series of milk-pans on a smaller scale, but similar in construction, without the compartments, and with a tap and two waste-water pipes, for regulating the circulation of water. The depth of the pan in both cases does not exceed a few inches. It is as yet an open question as to the depth of milk which yields the highest percentage of cream. It is reasonable to suppose that cream rises most rapidly in shallow vessels. There is an equally-divided opinion as to the material best adapted for making the pans.

The exhibition of churns was very large, and the principle varied greatly. We are glad to notice that exhibitors have abandoned the attempt to make *time* the principal object in their inventions; very rapid is not, as a rule, economical churning. Another point is that the cream may be subjected both to too rapid and too violent action, whereby the fatty globules are broken and the quality and keeping properties of the butter injured. In at least two churns, viz., the rectangular and the oscillating, the agitation is secured by the motion of the box itself, without the aid of fans, dashers, etc. And we believe that the old form of barrel churn, with fixed dashers, is still the most common and reliable form of power churn. Great progress has been made in the improvement of butter-working machines.

P. SHAW, *Scituate, Mass.*

The power-worker of this exhibitor is noteworthy, both for its simplicity of mechanism and efficiency of action. The apparatus comprises a vertical screw-press, to which is communicated an up-and-down motion by a crank underneath, and a revolving circular table, adjustable as to position in reference to the press. This table revolves upon and forms the top of the buttermilk receptacle, which is also an ice-box when required. The operator revolves the table as required, so as to bring every portion of the butter under the action of the worker. The latter is made of perforated iron, tinned over, covered with a cloth, and having on the upper side a small box containing a sponge. Any buttermilk squeezed out upwards passes through the perforations, and is absorbed by the sponge. The table is also covered with a cloth, in which the butter, when the operation is complete, is removed to the packing department.

P. Embree & Son, *West Chester, Pa.*

This hand-machine is equally meritorious. It comprises a revolving cedar-wood table, with a convex surface, on which the butter is placed and pressed by a revolving conical, fluted roller, with cleaner attachment, actuated by lever-handle. At the opposite end of the roller-shaft is a small pinion, working into toothed gear in the centre of the table, causing the latter to revolve, thus insuring the thorough working of the butter. All liquid expressed finds its way by a channel to an opening in the edge of the table. The roller is easily detached, and both it and the table are readily cleaned. The efficiency of this machine renders it applicable to all but the largest factories.

Universal Strainer Company, *Rutland, Vt.*

An excellent tin strainer and cover, which should be universally employed. It consists of a funnel, with a conical strainer of fine wire gauze in the centre of the bottom, which again is covered by a movable cap, also furnished with gauze. Thus the milk is twice strained, and the gauzes are so arranged that the weight of the milk cannot force the sediment through.

John Mathews, *Pleasant Grove, Pa*

A highly ingenious device, in which the box is raised after the butter has been pressed, for the removal of the butter, and can be easily detached for cleaning purposes. The press is worked by a sun-and-planet gear.

Speakman, Miles, & Co., *West Chester, Pa.*

A clever arrangement for the same purpose, viz., a hinged box, working down on a movable mould; the press is worked by a spring and lever.

Iron-Clad Can Company, *New York, N. Y.*
H. H. Roe & Co., *Madison, Ohio.*

Of displays of milk-cans, for transporting milk from the producer to the factory, or for town trade, these were the principal exhibitors, and both showed highly-finished apparatus suitable for the purpose.

J. G. Koehler, *Philadelphia, Pa.*

The butter-tubs shown by this manufacturer are intended to convey the butter after it has been prepared for the retailer. They are made of cedar-wood, with convenient shelves for the packing of the butter, and two ice receptacles.

ORANGE COUNTY PAIL COMPANY, *New York, N. Y.*

A large exhibit of well-made oak pails, with convenient fastenings, for conveying the butter in bulk.

CLASS 680.—LAYING OUT AND IMPROVING FARMS.

This class included some highly-interesting exhibits, a few of which may be noted.

S. W. HALL, *Elmira, N. Y.*

His universal fencing-machine is a most valuable invention, not only rendering the operation of fence-making more rapid and economical, but resulting in a more perfect fence than could be made by hand. The machine comprises a circular saw, a reducing and tenoning arrangement, by which the rails are prepared for insertion into the posts, and a series of augers by which the holes are bored and countersunk. After one set of holes are bored the position of the post is changed, and a second set of holes, occupying intermediate spaces on the opposite side, are made, which completes the operation, and all that remains is to set the posts and drive home the rails. The counter-sinking of the holes, allowing of a tight water-proof joint, insures durability. The cost of the machine is $300, and Mr. Hall states that two men and a boy can prepare from fifty to eighty rods of fence per day, and that the saving of material much more than pays for dressing. If desired, wire can be introduced to replace all but the top and bottom rails.

THEODORE F. RANDOLPH, *Morristown, N. J.*

Of the ditching and excavating machines shown, this exhibit denoted most progress, and greatly expedites drainage-work. It comprises a beam supported on four wheels, the centre of which is the cutter-wheel, so arranged as to take out a given depth at each revolution, bring the soil up with it, and distribute it on either side of the cutting. The implement is made of different sizes, according to the nature of the work and the power to be employed; that shown in Agricultural Hall was for two or three horses, and was calculated to dig drains thirty inches deep, doing the work of twenty men.

A. C. BETTS, *Troy, N. Y.*

A very admirable wood and wire fencing-machine for making light, temporary fences for sheep, etc. The wire is placed between the machine in coils, a boy feeds the wooden uprights in the machines;

the staples, which are suspended on inclined rods, come to their place over the wire, and are driven into the wood by hammers regulated by cam-gearing. The distance between the wooden uprights is either six or twelve inches, according to the purpose for which the fence is intended. The uprights are made 1¼ by 1½ inches, and 4 feet long. As fast as the fence is made it is rolled up for transportation. Two men and one boy can make two hundred rods of fencing a day.

P. J. STRYKER'S SELF-LOADING EXCAVATOR, *New Brunswick, N. J.*

A very efficient machine; the elevator is between the front wheels, and can be raised or lowered as required. Behind the excavator is an elevator connecting with the cart, worked by chain-gear from the hind wheel; the driver's seat is immediately over the elevator, and the cart or receptacle has a hinged bottom, in three divisions. A leverage, of which the handle is within reach of the driver, allows of the load being discharged by opening the hinged bottom.

HUBER MANUFACTURING COMPANY, *Marion, Ohio.*

Of the road-scrapers shown, that manufactured by this company, on the same principle as the revolving horse-rake, appeared the most practical and complete. The workman, by releasing the connection of the handles with the box, allows the draft of the horse to pull over the latter, which is returned to its place by pressing on the handles. It is both cheap and efficient.

RHODES & WATERS, *Elyria, Ohio.*

A clever post-hole digger, which we subjected to a severe test, viz., digging a hole on the grove road outside Agricultural Hall. It consists of a pointed digger, steel blades attached to double handles. When the hole is being made the handles are kept close; when the soil is to be removed the handles are expanded, which brings the blades together, their concave interiors forming the receptacle for the soil. By the use of this tool a great saving may be effected in putting down fence-posts.

A. C. COTTON, *Vineland, N. J.*

A stump- and rock-extractor, which combines the ratchet-wheel and lever, thereby insuring safety, and gaining great power with a slow motion. The chain is secured on a sproggle-wheel, which is on the same axle as the ratchet-wheel; slipping is impossible, and the

machine can be worked by one man. The object can be raised sufficiently high to put a sledge under.

BOWEN & RIDER, *Vineland, N. J.*

This extractor operates by a double leverage, with dogs. The fulcrum is one and a half inches, and each lever can raise fifteen tons. This is also an efficient machine. There is a great opening for such machines in many parts of the country where fresh land has been recently broken. The stumps are not only an eye-sore, but a serious impediment to good cultivation.

CLASS 683.—MISCELLANEOUS.

Under this head were included a great variety of exhibits, more or less agricultural in their objects, but generally displaying that ingenuity of construction and adaptability of purpose for which American inventors are so justly celebrated. The section of wind-engines contained several exhibits. These powers are found of great use for pumping purposes; they vary considerably in construction, but adopt the Rosette principle, with several modifications.

UNITED STATES WIND-ENGINE & PUMP COMPANY, *Batavia, Ill.*

This engine, which probably obtains more power, according to diameter, than any other, has sections on transverse axles; these are held straight to the wind by means of a balanced lever-weight, where the centrifugal force overcomes the weight. The sections open so as to adopt the same direction as the wind, and consequently the mill is checked. But as soon as the velocity decreases the balance-weight comes into play again. The sections catch the wind, and the result is that the mill runs steadily in a high wind, when some others have to be stopped. This is a very ingenious arrangement, and great improvements have recently been made by the use of small counterbalance weights on the sections themselves, giving the mill a greatly increased power. The disadvantage of this mill is the complication of parts, requiring more attention in oiling, and the extra cost.

ECLIPSE WIND-MILL COMPANY, *Beloit, Wis.*

A form of the solid Rosette wheel, which, though less powerful, has some advantages. Here an adjustable side vane, which is a patent, acts as an over-balance, and draws the sail away from the wind, but does not interfere with the efficiency in a light wind, because it must first overcome the leverage of a weighted arm, which is also adjustable. The

engine can be quickly stopped by pulling down the lever, which brings the wheel-edge to wind. The turn-table travels on four friction-balls, running on a grooved surface. The table casting is in one piece with the cap or bed-plate, and has flanges on the under side to receive the head of the post. This mill is very well made, and appears a cheap and valuable invention.

E. STOVER & BROTHERS, *Freeport, Ill.*

These makers also use the solid Rosette. The wheel is dished inwards, and strongly braced by the felloes, which are round. Here a balance-weight is employed to keep the mill face to wind. When the force of the wind overcomes the weight, the mill is brought edge to wind. The frame is made of four pieces of timber, bolted together like a camp-stool. The turn-table sets on an anti-friction table, with sixteen cast-iron balls. This makes the mill very sensitive, and allows of a comparatively short vane being used. The vane-beam has a spring clutch acting on the crank, and stops the machine entirely if required. The shaft-casting is in two parts, with india-rubber between to compensate for wear. This is a strong mill, suitable for a farmer's purpose.

GAMMON & DEERING, *Chicago, Ill.*

In this engine the Rosette is in six sections, actuated by spring and leverage, which causes the fans to open. The stroke is variable, according to the force of the wind. This is effected by having the crank-shaft bent, and acted upon by the spring on the Rosette standard. When the wind is strong, the crank is forced back, and the stroke is lengthened. The connecting-rod is attached to the crank by a ball-and-socket adjustment. This is an ingenious arrangement, but, as the machine was shown in Agricultural Hall, we had no opportunity of judging of its behavior in a strong wind, and therefore refrain from any opinion as to its practical utility.

O. F. TIFFANY, *San Francisco, Cal.*

Fruit-drying is an important interest, and we found several exhibits of machines for this purpose. One of the most complete arrangements was Mr. Tiffany's, which has a hot air-chamber in the basement, with two dampers for the admission of cold air,—one into the chamber and one above, the draught-stack forming a natural draught. The roof of the apparatus is so constructed inside as to form a vapor conductor. The moisture thus collected empties into a conductor, with siphon-spout filled with water, thus the escape of heat is pre-

vented; the sieves are arranged on a frame, which runs on wheels, and can be readily removed when the process is completed; all the trays can be shifted from story to story by an elevator.

JONES BROTHERS, *Sturgis, Mich.*

In this apparatus, for the same purpose, the principal feature is a double-action fan worked by horse-power, the degree of heat being regulated by a shutter. The screens are in ten sections, and the fruit is passed forward according to condition. The merit claimed for the machine is that, owing to the action of the fan, the fruit can be dried more rapidly, and at less cost than in any other machine.

GEO. A. DEITZ, *Chico, Cal.*

This is the largest machine of all, having 420 feet of drying surface; the arrangements for regulating temperature and securing perfect circulation of hot air are excellent. The screens of galvanized iron run upon rollers, and are easily removed.

H. BURDEN & SONS, *Troy, N. Y.*

A model of a machine for making horse-shoes was shown by this house, who have a large and important manufacture. Specimens of the hematite and magnetic ore used, together with the pig-iron, large and small bars, were shown. The latter, when rolled out to the proper dimensions, are passed at once to the mill, into which they are fed by two fluted rollers. First the iron is cut off at the proper length, then the shoe is formed; next it is stamped by passing between an upper and lower die. The holes are not punched, but a crescent die marks the place where the holes are to be made; lastly, the shoe is straightened by a press; sixty shoes per minute can be made. The machine has only four gear-wheels, is simple in construction, and very strong. The works are very extensive; 1400 hands are employed, and the factory has an annual capacity of 600,000 kegs, of 100 pounds each, equal to 60,000,000 pounds.

GEORGE NEIGHBOUR & SONS, *London, England.*

The apiaries shown by this firm deserve recognition as cheap, economical, and well adapted for securing the honey without destroying the bees.

R. R. MURPHY, *Fulton, Ill.*

A machine excellently adapted for extracting the honey without destroying the comb. This machine comprises a copper cylinder,

tinned on the inside, with a revolving rectangular frame or box, the sides of which are covered with fine wire-gauze. The comb, taken from the hive before the last process of sealing up the cells has taken place, is placed in the frame or box, which is revolved by a handle and bevel-gear; the centrifugal force causes the honey to discharge into the cylinder, from which it is drawn off without injuring the comb, which is replaced in the hives and refilled. This is a very ingenious device for securing the maximum produce.

JONA BIGELOW & CO., *Boston, Mass.*

An extremely ingenious device for labeling cans or bottles, comprising an inclined plane, composed of copper plates covered with flannel. The can is set in motion down the incline; first passes over a paste-roller, which is covered with flannel, and takes up a supply of paste from a receptacle below; next the label is attached, being taken up by the can in its passage over the label reservoir or chamber, which is so adjusted as always to present a label to the surface of the can; farther on an upright lever is passed over and compressed; this, by a clever cam-gear, raises a gum-brush, which gums the edges of the uppermost label ready for the passage of the next can; this is particularly clever, as the gummed edge is required to insure a perfect adhesion. The can, with label duly attached, is discharged from the bottom of the machine. This work was formerly done by children, and a great saving both in time and cost is effected.

BOOMER & BOSCHERT PRESS COMPANY, *Syracuse, N. Y.*

In cider-mills this establishment takes the lead, exhibiting an apple-mill, the cylinder of which is furnished with a number of knives, its sections being adjustable by two screws. The fruit is held to the cylinder by means of a spring-jaw, which is adjustable. The fruit, after passing through the mill, falls into an open box, divided into two compartments by a movable door, so that the material can be delivered from either end to the press. The latter is of extremely powerful construction, consisting of a cross-screw with a double-leverage thread. The motion downwards is slow, so as to insure the full action of the press; the screw stops itself, and rises five times as rapidly as it falls. A similar press was also shown for hand-power.

KEYSTONE MANUFACTURING COMPANY, *Sterling, Ill.*
P. P. MAST & CO., *Springfield, Ohio.*
THOMAS, LUDLOW, & RODGERS, *Springfield, Ohio.*

In the hand-power mill of the Keystone Manufacturing Company,

the hopper is provided with an adjustable jaw and small roller to regulate the feed. The mill consists of two horizontal rollers with conical sections fitted into each other, and covered with numerous small projections on the surface, which greatly increase pressing surface and efficiency. The rollers are differently speeded,—one revolving three times as rapidly as the other secures great efficiency; all the bearings are adjustable, to compensate for wear. The press is worked by a powerful screw, to which the follower is attached, which, however, can be readily removed if desired. The other machines are very similar in principle, but differ in details.

Included under miscellaneous exhibits were a large collection of meat- and sausage-choppers, fruit- and potato-peelers, etc.,—designed for domestic economy,—ice-freezers, refrigerators, bird-cages, etc., of which, speaking generally, we may say that the exhibits were highly creditable to the makers.

In the above report, which has been necessarily hastily compiled from notes taken during our examinations, we have endeavored to convey a general, rather than a particular, description of the more prominent exhibits.

REPORTS ON AWARDS.

GROUP XXIII.

1. Israel L. Landis, Lancaster, Pa., U. S.

DURABLE SAFETY SWINGLE-TREE.

Report.—Commended for the very ingenious arrangement by which the traces can be instantly detached from the swingle-tree of a buggy or any single-horse carriage, and which answers admirably, provided the adjustment of the remainder of the harness allows of the animal getting clear. There must be no breeching straps attached to the shafts, and the tugs must be large and kept in front of the stop. The device consists of a sliding fork at each end of the swingle-tree, acted on by a strap leverage from driver's seat. By pulling the straps the forks slide forward and throw the traces off.

2. Chicago Scraper & Ditcher Co., Chicago, Ill., U. S.

ROAD SCRAPER.

Report.—A strong, useful machine, shod with steel, with adaptable pitch by a chain, and facilities for emptying.

3. Munsell & Dexter, New York, N. Y., U. S.

LEVER JACK.

Report.—Commended for its utility as a farm implement, strong and durable, easily applied, and very powerful as a press and jack for lifting; very simple in construction; operated by means of a lever with two ratchets on the end that works in notched upright; the fulcrum being short gives the operator great power.

4. Huber Manufacturing Co., Marion, Ohio, U. S.

ROAD SCRAPER.

Report.—It revolves on the same plan as their horse-rake; a catch spring holds the box in place; when loaded the spring is released, and by raising the handles the draft of the horse carries over and upsets the box. The bottom of the box is of steel strongly riveted to iron sides. This is a strong, handy machine, reasonable in price.

5. Milburn Wagon Co., Toledo, Ohio, U. S.

FARM, PLANTATION, AND FREIGHT WAGONS.

Report.—Commended as being well made, of the best timber, and thoroughly ironed; the bolster plate particularly large, level, and strong; wheels strong and substantial, the wooden axles having powerful and well-adjusted skeins.

6. Kansas Manufacturing Co., Leavenworth, Kan., U. S.

FARM WAGONS.

Report.—Commended for excellence of material, thoroughness of construction, and beauty and perfection in finish.

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7. A. B. Farquhar, York, Pa., U. S.

HORSE GEAR FOR COTTON GIN.

Report.—Commended for the power of adjusting both vertically and horizontally, which is very important, as, owing to faulty constructions, the floors of the gin room frequently sway in consequence of too long bearings, and but for this arrangement the gear would inevitably get out of order.

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8. Heebner & Sons, Lansdale, Pa., U. S.

RAILWAY HORSE POWER.

Report.—Commended for level position secured to plank upon which the horse steps, dispensing with expense of sharp shoe calks and continual wear of plank; and for security obtained to man and horse by means of a governor placed on shaft inside of belt wheel, acting independent of brake; and for cheapness and durability.

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9. W. L. Boyer & Brother, Philadelphia, Pa., U. S.

UNION HORSE POWER (BURT'S PATENT) AND COMBINED METAL MILL AND BOLTING SCREEN.

Report.—The Union horse power is commended for strength, durability, and efficiency, due to the use of good materials and the peculiar arrangement of the running gear. The driving gear wheel is placed directly under the motive power, and is large enough to cog into the chain links both above and below: thus is secured a double leverage with direct action, and so the connecting pivots of the chain are relieved from all strain and friction whilst passing the end track. Power can be applied at a less acute angle, consequently wear and tear of the horse is reduced. Multiplying gearing is employed to get up speed.

The combined metal mill and bolting screen is commended for strength and durability of wearing parts, for efficient operation, and suitability either for grain or Indian corn. This is a conical mill, working horizontally, with fluted sections; concave has also raised surfaces. Edges sharpened by contact; material cast steel; for clever jigger from wheel, which agitates hopper and screen. The mill is adjustable at the end by set-screws. A separate opening in the box allows of the cobs coming in contact with a breaker, a cast bush with convex teeth keyed on to the shaft. Bolting cloth can be applied or not, as required.

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10. Henry S. Vanderbilt, Washington, D. C., U. S.

WAGON JACK.

Report.—Commended as consisting of an upright ratchet that works in a frame and is raised and lowered by small cog wheel, operated by a lever and drop catch on short fulcrum, giving great leverage power; the load is securely held by a separate drop catch that is hinged on the frame of the upright. It is very durable, and easily operated.

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11. Lehigh Car Manufacturing Co., Stemton, Pa., U. S.

FARM AND EXPRESS WAGONS.

Report.—This wagon, besides being well made and thoroughly ironed, has a novel, peculiar, and useful feature. The "fifth wheel," instead of being made of a flat ring of iron attached to the axle, with another corresponding one on the body, consists of a single ring resting in a frame on springs which are attached to the axle, and made with its front and

rear portions gradually raised. The body of the wagon rests partly on supports touching the raised points of the wheel and jointly on rollers resting on its depressed portions. As the forward wheels are turned, the circular movement of the fifth wheel brings the rollers supporting the body up the raised portion till at the highest the fore wheel may run under the wagon body. This is effected in the easiest possible manner and with very little friction. The king-bolt passes down through a hollow cylinder or tube of iron, which is bolted to the body of the wagon, and it is screwed underneath the platform; around the king-bolt is coiled a spring pressing against the head of the king-bolt and forcing it up as the body rises by the action of the fifth wheel on the rollers. The whole arrangement permits a wagon to be turned in a very narrow compass and with great ease, and permits large forward wheels.

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12. S. W. Hall, Elmira, N. Y., U. S.

UNIVERSAL FENCING MACHINE.

Report.—Commended for the ingenious combination of a circular saw, a large auger or tenoning machine, a reducing machine for preparing the rails for the tenoning process, a gang of five augers with countersink attachment behind, so that the post can be bored and the holes countersunk to the exact size required for a tight joint; for the ease with which the position of the post can be altered so as to allow of a second set of holes being bored at the proper position; and for the excellent, well-stayed, and durable fence which results from the operation described. Such a machine has a high value when large works are in hand and manual labor is scarce.

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13. S. N. Gustin, Mexico, Oswego County, N. Y., U. S.

ANIMAL POKE.

Report.—Commended for peculiar adaptability for the purpose designed, consisting of a wooden bow, adjustable as to size, hung on malleable iron cross head of the poke, held by spring-seated ratchet; on the upper side of the breast-block is a spring gear. When the poke comes in contact with a fence, the pressure of the bar on the spring causes the animal to be pricked by two sharp pins. Also for cheapness and durability.

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14. A. C. Cotton, Vineland, N. J., U. S.

STUMP AND STONE EXTRACTOR.

Report.—Commended for ingenious construction, efficiency, simplicity, and durability. A long lever, whose fulcrum may be changed according to convenience, works on a ratchet and sprocket wheel of sixteen inches diameter, giving great power to the workman. The whole apparatus is attached to a tripod, which may be easily changed from one locality to another.

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15. P. I. Stryker, New Brunswick, N. J., U. S.

SELF-LOADING EXCAVATOR.

Report.—Commended for the efficient manner in which the load is discharged from the cart by tipping hinged bottom in three divisions, an arrangement that might be usefully applied in other directions. We notice the simple gearing on the front wheels by which the plow or scoop can be elevated for traveling, and the efficient elevating arrangement by which the soil is conveyed from the scoop to the cart.

16. Bowen & Rider, Vineland, N. J., U. S.

STUMP AND ROCK EXTRACTOR.

Report.—Commended for strength, simplicity of design, great power, and quick action. The machine, having two levers, can be worked by one or two men as desired. The load is held by dogs, the action is direct and immediate; when the load is raised, it can be easily unloaded.

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17. J. A. Treat, Cleveland, Ohio, U. S.

SELF-OPENING CARRIAGE GATE.

Report.—Commended as a highly ingenious combination of levers, by which a wheel or horse pressure on a plate or upright bar causes the gate to swing open and shut by corresponding action on the opposite side. The gate is made adjustable so that it can be raised to a certain extent in the event of obstructions, snow, etc., being in the way. This adjustment is also important to overcome sagging or variation in position of the post. This is very necessary, as the jar of the swing is likely to cause displacement. The question is how long the various levers would continue in working order.

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18. Albert C. Betts, Troy, N. Y., U. S.

MACHINE FOR MAKING WIRE FENCES AND READY-MADE WIRE FENCING.

Report.—Commended for ingenious construction and valuable products. This machine is capable of making from two hundred to three hundred rods of fencing per day, requiring only one horse-power, and the attendance of two men and a boy.

The machine is provided with a set of reels containing wire of which the fence is made, also a set of staples, drivers, and two sets of hammers, all operating automatically, driving the staples over all the wires firmly into the pickets, which are fed in the machine as fast as a boy can handle them, and carried through by means of an endless chain. The number of pickets may be changed from fifteen to thirty to the rod, and the numbers of wire from three to six. The bundles are made to contain from six to ten rods rolled up in barrel-shape,—easy for transportation. The fence is not only strong enough to protect crops, but entirely safe for cattle or horses, and is undoubtedly of great value in any country where wood for fencing purposes is scarce.

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19. Theodore F. Randolph, Morristown, N. J., U. S.

DITCHING AND DRAINING MACHINE.

Report.—Commended as an ingenious and efficient machine for draining or ditching purposes. The two-horse-power machine is well suited for drainage operations, cutting out the ditches five inches wide and thirty inches deep, thereby effecting a great saving over manual labor. The large machines have still greater labor-saving power. A machine drawn by six horses will cut ditches from twelve to thirty inches in width and from thirty to forty inches deep. A cut six inches deep and twelve inches wide can be made as fast as horses can walk. The machine can also be worked by a traction engine or by stationary steam power.

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20. W. Anson Wood, Albany, N. Y., U. S.

REAPING MACHINE.

Report.—Commended as a strong, serviceable machine, simple in construction and efficient in operation.

The cam head of malleable iron is fixed low and is protected by a shield; switch trip automatic, and controllable; rake orbit secures good collection, and leaves clean gavels; large driving wheel, moderate draft, and reasonable price.

21. Otis Brothers & Co., New York, N. Y., U. S.

(HAYMAKER) MOWING MACHINE.

Report.—Commended for a novel and beautiful motion, by which the power is conveyed from the traveling wheels to the knife by means of one pair of bevel wheels only. This is effected by means of a gimbal joint carrying the driven wheel instead of revolving, to make a succession of serpentine vibrations around the face of the driver, and an arm extended from this vibrating disk gives the necessary movement to the knife. In this peculiar motion, which is partly dependent upon the fact that the gears are differential (the driver having forty-one teeth and the gimbal wheel forty-eight), at least eight teeth are always engaged at once, thereby distributing the strain more evenly than in ordinary gearing.

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22. The Towanda Eureka Mower Co., Towanda, Pa., U. S.

DIRECT-DRAFT EUREKA MOWING MACHINE.

Report.—Commended for the introduction of an entirely new principle by that of direct draft. The horses are attached to the centre of the machine, one horse walking on the standing grass; but the cut grass is not trodden at all, and, owing to the presence of double clearers which are composed of light iron rods, the grass is left raised up, and so light upon the ground that curing follows without aid of tedders, etc. For the great advantage of being able to work the land in any direction, up or down the hill, and thus attack difficult crops in the best way. For the excellent arrangement by which flexibility of the knife is secured. The latter is placed in front, and is drawn by means or through a rock shaft. For lightness of drag, and owing to large driving wheels and great capacity for rapid work on level land.

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23. Adriance, Platt, & Co., Poughkeepsie, N. Y., U. S.

MOWING MACHINE (BUCKEYE MODEL).

Report.—Commended for strength and simplicity of construction, and for attention to details. The pitman is of malleable iron; brass bushes are used which can be cheaply replaced; large oiling space. The drag bar of tubular cast iron strongly braced. The gearing being principally outside the machine counteracts the draft of the cutter bar. The bar for traveling folds over the frame, which is a convenient arrangement. The shoe is removable, and its position can be altered to secure different heights of cut. No arrangement for adjusting the pitch of the fingers during work: this we consider a drawback,—not, however, sufficiently so to exclude this machine from favorable consideration.

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24. Whitman & Miles Manufacturing Co., Akron, Ohio, U. S.

MOWING AND REAPING MACHINE KNIVES, SICKLES, AND SECTIONS.

Report.—Commended as fine in quality, of high finish, and all approved forms required by manufacturers of reaping and mowing machines. As a collection of great variety and marked merit, they give evidence of a well-established and carefully-conducted manufacture. Special attention is drawn to the new sickle-edge reaping sections, which present a finely serrated surface without face bevels, thereby insuring increased wearing surface, with a self-sharpening edge. All sections are made of the best English steel.

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25. J. F. Seiberling, Akron, Ohio, U. S.

MOWER.

Report.—Commended for a novel application of gearing. The driving pinion placed on the main shaft is cast with two alternating rows of teeth, which secure a continuous and

regular motion, and in the event of a tooth breaking, the regularity of the same is not interrupted. This arrangement is described by the inventor as alternate and intermitting gear.

26. Warder, Mitchell, & Co., Springfield, Ohio, U. S.

MOWING MACHINES (CHAMPION PATTERN).

Report.—Commended for strong durable construction on similar patterns as the Champion Machine Company; rear cut; the knife-bar on a parallel drag bar can be set to any angle while at work.

27. The Johnston Harvester Co., Brockport, N. Y., U. S.

MOWER, REAPERS, AND COMBINED MACHINES.

Report.—A large exhibit of machines. Commended for excellent material, strength, durability, finish, and attention to details, as evidenced by the following facts. Solid wrought-iron frame. Table attachment very strong, and easily adjustable by lever and outside wheel that runs in a crank shaft. Pitman rod attached to knife by ball and socket, giving great elasticity. Patent key nuts easily adjustable to compensate for wear. Motion communicated to rake shaft by square-linked chain-gear, with spring tension rollers. Cam gear for traverse of rake; original, automatic, and controllable. Speed of knife can be changed by reversible pinions. Driver's seat balances the pole. The machine works with little noise, indicating little friction. Prices reasonable.

28. Rochester Agricultural Works, Rochester, N. Y., U. S.

REAPING MACHINE (TWO WHEELS).

Report.—Commended for the special features in this machine which appear worthy of commendation: first, the rakes are driven by slack chain-gearing through sprocket wheels; secondly, the driving gear is balanced by the use of two pinions on either side of the driving wheel, which is placed on the main shaft. The raking mechanism is on the improved Dorsey principle; a movable latch, worked by foot leverage, makes the rakes controllable.

29. C. H. McCormick & Co., Chicago, Ill., U. S.

MOWING MACHINES.

Report.—Commended for being simply made, and for making capital work both on upstanding and laid crop; partly due to the high speed at which the knives are driven. For the excellent connection of knife-bar to frame, by means of a two-and-a-half-inch wrought bar well braced by a bar behind. The knife works behind the centre, and the draft is certainly not so light as some others. The fingers, which are steel-faced, are firmly attached to the bar by three bolts to each.

30. Bradley Manufacturing Co., Syracuse, N. Y., U. S.

MOWING MACHINE.

Report.—Commended for being well made, having change of speed pinions. The connecting-rod attachment allows of the knife-bar working at any angle without strain or undue friction. The gearing is well covered. The driver's position balances the pole. The frames are raised or lowered without affecting the draft.

31. D. M. Osborne & Co., Auburn, N. Y., U. S.

BURDICK REAPER.

Report.—Commended as a well-made, light-running machine, with excellent raking apparatus. The cam table is placed low, and the rakes pass the knife in a nearly parallel line, securing even laying of grain on table. The cam table is unusually large, and the traverse of the rakes consequently steady. The rake-heads are provided with large gathering surface, valuable in the case of laid grain. The knife and rakes are driven from the same shaft by bevel gearing.

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32. George Esterly & Son, Whitewater, Wis., U. S.

HARVESTER REAPING MACHINE.

Report.—Commended as a decided improvement upon the ordinary form of harvesters. The traveling platform and elevator being replaced by a fixed platform, the grain (as fast as it is laid on the platform by an ordinary adjustable reel) is swept up an inclined plane by means of a collecting rake which is balanced by a weighted arm. This works quite independently of the reel, pursuing a different orbit. The grain is thus landed on the tying-table. The workmen are seated on either side, and the grain is brought to them in bundles suitable for tying, by means of a traveler. This traveler is worked by a cam on the second gearing wheel, which actuates a sun-and-planet gear. The advantages are diminished gearing and reduced friction. The grain is not so liable to be knocked out, and the traveler greatly facilitates the binding operations. In a light crop and with moderately short straw, two men thus assisted could tie the grain as fast as presented.

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33. Hillborn, Buckman, & Co., Newtown, Pa., U. S.

HALLENBECK REAPER.

Report.—Commended as a strong, well-made machine, with good cutting and cleanng mechanism. The peculiar arrangement of the crank shaft gear allows of the knife-bar being placed nearly in line with the axle of the wheel. The crank rod is bent, and has a bearing at either end. The connecting rod connects with it in the centre; a balance wheel being placed at the opposite end of the crank rod secures steadiness of motion. The primary motion is through bevel gearing.

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34. Whiteley, Fassler, & Kelley, Springfield, Ohio, U. S.

SWEEP RAKE REAPER (SIX-FEET CUT).

Report.—Commended as a well-made, serviceable machine, of the Champion pattern, with rake head set very low, which insures the grain being laid straight on the table. The form of cam gear allows of the collectors rising somewhat obliquely, thereby inclining the grain in the right direction and allowing of successful operation when the crop is laid. The cam gear (Dodge's patent) is of malleable iron, driven by universal telescope joint from main axle, which allows of the elevation or depression of the table without increase of strain; knife gear outside the traveling wheel; main frame in one piece of wrought iron, three-quarters by two and a half inches; platform connected with main frame by strong brace with two bearings securing liberty and strength; gavels uniform and well laid; machine commendable for strength and simplicity.

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35. Rochester Agricultural Works, Rochester, N. Y., U. S.

COMBINED MOWER AND REAPER (HUBBARD).

Report.—Commended as an efficient machine for either purpose. As a reaper the method of altering the rakes is simple and ingenious. This is effected by means of three

small gearing wheels. The driving pinion has fifteen cogs; the intermediate wheel twenty-eight cogs; and the third has twelve cogs, three cogs to represent each rake arm, either wheel made to act by a clutch stop. The action is either automatic or controllable. The knife can be driven at two speeds by change of pinion, which can be effected while in work. The rake shaft is driven by pitch chain from axle of inside wheel. In many respects this is a useful combination.

36. Bradley Manufacturing Co., Syracuse, N. Y., U. S.

HORSE RAKE, REAPING MACHINE (HARVESTER REAPER).

Report.—The horse rake is commended for the method of dumping, which is effected by a double lever acting on clutch gearing on both wheels. The clutches are distinct from the wheel, being bolted on, and are easily replaced. The frame is independent of axle. The teeth, which are set too far behind the centre, admit of some adjustment by lengthening or shortening the leverage. Action easy.

The reaping machine is commended for balance of working parts, great facilities of adjustment to suit varying crops, snug arrangement of gearing, which allows of the knife-bar being placed in a line with the axle of the main wheel; for good cutting and well-made gavels, lightness of draft, and general excellence.

37. C. Aultman & Co., Canton, Ohio, U. S.

MOWING MACHINE (BUCKEYE).

Report.—Commended for a well-made, strong, serviceable machine with the following special features. The knife-bar is attached to the frame in front of the driving wheels. This has some advantages. The side strain is reduced, because the weight of the cutting is balanced by the frame and the driver. The guards are rolled out of wrought iron, the under surfaces on which the knife plays are faced with one-eighth inch steel, and the points are also steeled. The under sides of the guards are beveled, so that the minimum of metal shall be on the surface of the ground. The wrist of the pitman works in a box on a crank. This prevents shaking. The crank-rod guard or box is adjustable to meet the wearing of the rod. The frame is cast in two pieces. The gearing is strong and well protected. The first motion is contrary to usual custom, that of bevel wheel running on to spur gearing. The reason assigned for the change is that the wheels most liable to wear should do the slower work. The knife makes forty-two vibrations for each revolution of the wheel, the diameter of which is twenty-nine and one-quarter inches. The frame is so hung upon and rolls over the axle that alteration of the angle of the knife-bar does not cause more friction. The gearing is well balanced, so that there is no undue pressure on the horses' necks. This machine works quietly. The pitch of the finger-bar is adjustable by means of a lever which is attached to the front of the shoe and can be actuated while the machine is in work. This is a desirable feature, enabling the workman to cut out a dead furrow, or to alter his machine for a laid and twisted crop. Nothing is more objectionable than to find a field otherwise well cut disfigured by patches of long, tough grass.

38. C. Aultman & Co., Canton, Ohio, U. S.

IMPROVED BUCKEYE MOWER AND TABLE-RAKE REAPER.

Report.—Commended as being practically the same machine as was shown by Aultman, Miller, & Co., to which our report equally applies. Some description of the *modus operandi* may be given. The knife is placed in front of the driving wheels, a ratchet wheel on axle of inside driving wheel communicates motion to a pinion by means of chain gearing with spring tension pulleys. Then motion is communicated to table by universal joint, terminating in a bevel pinion, well shielded, which drives bevel wheel, to which the rake is

attached. Orbit of rake shaft determined by cam gear protected by a shield, part of which is hinged. The workman, by throwing it out of gear, can stop the rake at any point of its traverse.

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39. Aultman, Miller, & Co., Akron, Ohio, U. S.

THE NEW BUCKEYE COMBINED TABLE-RAKE REAPER.

Report.—Commended for the superior form in which the gavels are left for facilitating the binding, over sweep-rake machines. The grain is laid straight on the platform by the reel, because the latter is parallel with the cutter-bar, and its motion uniform along its whole length. The table-rake compresses the grain and delivers it in a closer form and with the straw more parallel than the sweep-rake, which, entering and leaving the crop more or less obliquely, has a tendency to fan out the butts of the gavel, which, while of great advantage when the crop is green and requires field room, adds to the labor of binding, and is of no merit in a ripe crop. The reel, being capable of more adjustment to suit uneven and laid crops, may be expected to work well under difficulties. The workman having control of the revolutions of the table-rake can make the gavels of any size, or the action can be continuous; on the other hand, it is evident that the pressure of the rake-head on the grain at the front corner of the table must have a tendency to knock out ripe grain more than a steady sweep motion.

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40. Sweet, Faulkner, & Co., Dansville, Livingston County, N. Y., U. S.

REAPING MACHINE.

Report.—Commended for very light draft, the machine weighing only four hundred and thirty-five pounds, for quality of material and workmanship, and for efficient operation. The cam gear is placed just above and clear of the platform. The rake-shafts are hung upon the standards, and, by means of an adjustable trip and spring, feather over the grain when acting as collectors, thus securing a pretty and effective action; a traveling wheel without spokes, periphery attached by solid external casting, allows of compact gearing and direct draft, the knife-bar being in a line with the axle. The rake-standard is driven by universal joint. The guards are reduced in number, with spaces between. This is a comparatively new machine, and without further experience it is impossible to express a positive opinion as to its durability and ability to deal with a weedy crop.

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41. The Champion Machine Co., Springfield, Ohio, U. S.

COMBINED REAPER AND MOWER (AS A MOWER).

Report.—Commended for strong durable construction. The frame is of wrought iron bolted together. The height of cut regulated by good leverage and pitch of knife-bar can be altered while at work. The advantage of this adaptability was evident when the machine followed the roller and cut the laid grass extremely close and even. The knife is driven from both wheels, by means of ratchet wheels on the spur pinion axle. The main axle is stationary and of cold rolled iron. The wheel axle has short bearings. The crank-shaft is of cast steel, has a bearing the whole length with an oil chamber in the centre. The nut of pitman holder is furnished with a ratchet and spring catch. The pitman has a ball-and-socket attachment. The bearings are large, and the wear is taken up by a screw. The finger guards are forged solid, the slot being cut out by a circular saw. No steel plates are used, but the guards are sharpened and case-hardened. The knives are made from four to six feet in length. The knife-bar is fixed fifteen inches behind the axle. The knife makes ninety-eight vibrations for each revolution of driving wheels, which are thirty-two inches in diameter.

42. G. H. Peabody, New York, N. Y., U. S.

ATTACHMENT OF SOLID EMERY TO WOOD IN A RICE-HULLER.

Report.—Commended as producing a surface admirably adapted to effect the shelling of rice, which appears to be extremely durable. Mr. Peabody shows this material as applied to a small rice-huller for family use. We recommend the material and the method of attachment to wooden surfaces.

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43. S. L. Allen & Co., Philadelphia, Pa., U. S.

HAND SEED-DRILL AND WHEEL HOE.

Report.—Commended as a valuable implement for garden culture. The drill consists of a revolving barrel with openings two and a quarter inches from centre to centre, with a regulating slide; each opening is covered by a cap or shield, which secures regularity of seed whatever quantity is in the box. The frame can be used as a hoe also. This firm also exhibits a strong, well-made horse hoe, with triangular frame; the hoe standards being fixed in slots allowing of variation.

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44. George Barnes & Co., Syracuse, N. Y., U. S.

KNIVES AND SICKLES.

Report.—Commended for excellence of material and good workmanship.

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45. Ball's Scythe Works, Saratoga, N. Y., U. S.

GRAIN SCYTHE AND CRADLE.

Report.—Commended for excellence of material and workmanship, and improved style of adjustment of the fingers; of great utility and convenience to the moderate farmer.

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46. Myers & Erwin, Philadelphia, Pa., U. S.

ASSORTMENT OF FORKS.

Report.—Commended for quality of material and good workmanship. A thoroughly useful assortment of straw and manure forks—ferrules well riveted.

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47. Pittsburg Plow and Crucible Steel Casting Works (J. C. Bidwell), Pittsburg, Pa., U. S.

STEEL CASTINGS FOR AGRICULTURAL IMPLEMENTS AND FOR OTHER PURPOSES.

Report.—Commended for the extent, variety, and general good quality of the castings presented,—affording evidence of the ability of the exhibitor to produce castings of cast steel of any desirable pattern and reasonable size, having great strength and durability, and tempered as required; also for collection of implements suitable for the cultivation of sugar plantations.

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48. Baugh & Sons, Philadelphia, Pa., U. S.

SECTIONAL MILLS.

Report.—Commended for strength of construction and varying utility, being capable of grinding bones, phosphates, rock guanos, minerals, and ores. The specially commendable feature is that all the grinding surfaces, both in the cylinder and in the cones, are in sections which can be replaced without renewing the whole, or can be substituted for other surfaces to suit different kinds of work.

49. C. B. Rogers, Philadelphia, Pa., U. S.

IRON CULTIVATORS.

Report.—Commended for easy adjustment from twelve to twenty-four inches, for arrangement of draft line by regulating screw, for good material and finish, and reasonable price.

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50. Lewis Lamborn, Hamorton, Pa., U. S.

HOE HARROW.

Report.—Commended for the method in which the hoe standards are secured to the frame, which is ingenious and efficient. The standards are drawn out U-shaped. On the under side of the frame is fitted an iron box. The hoe standard fits into this box, being secured by a wedge with a pin through the beam and nut screw. This hoe is designed principally for potato culture. A small front wheel carries on its axle a perforated dredger, which is intended to distribute Paris green when potatoes are affected by the beetle.

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51. Graham, Emlen, & Passmore, Philadelphia, Pa., U. S.

LAWN MOWERS.

Report.—Commended for good material, strong and durable mechanism, adjustable speed, considerable variety as to size and form. Horse machine with driver's seat, so arranged that the knife can be raised by lever handle clear of the ground. The fore and hind parts of machine jointed. Shaft of one and five-eighths steel. Cylinder rings malleable iron. Knives attached by screws, and readily adjusted by set-screw. Shaft held in place by two caps with pieces of leather between, which allows of adjustment for wear. Self-oiling journals. Horse attachment jointed and not rigid; an important arrangement, as workman can guide the machine independently of the horse.

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52. Maxwell, Rowland, & Co., Holmesburg, Philadelphia, Pa., U. S.

SHOVELS AND SPADES.

Report.—Commended as a large, well-assorted collection of shovels and spades, particularly for plain back shovels of cast steel, with straps welded to the blades, a strong attachment being secured without rivets, and for reasonable price.

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53. B. Rowland & Co., Philadelphia, Pa., U. S.

SHOVELS, SPADES, AND SCOOPS.

Report.—Commended as a large and varied assortment of exceedingly strong, well-made implements; for a recently patented shovel, all made by machinery, with long ferrule and close joint at the socket, made of two pieces of cast steel; and for very reasonable prices.

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54. Alexander Speer & Sons, Pittsburg, Pa., U. S.

REVOLVING HILLSIDE AND LEVEL LAND PLOWS.

Report.—Commended for the novel and ingenious arrangement by which the stilts and beam revolve on the standard frame. This movement is extremely simple. The workman actuates a lever in connection with a stop clip, thus setting free the beam, etc., and the horses in turning carry it round. The share and fore part of the mould board are in duplicate, with a revolving wing common to both; the first pressure of the turning furrows reverses the wing; price reasonable. Also, for a hillside sub-soil plow of similar principle; and for the general excellence of their large assortment of general purpose plows.

55. Auburn Manufacturing Co., Auburn, N. Y., U. S.

MANUAL IMPLEMENTS OF TILLAGE.

Report.—Commended for excellence of manufacture, quality of material, and general utility of the tools, consisting of steel forks, steel hoes, steel rakes, and potato hooks, all finished with best quality white ash handles; grain, grass, and bush scythes; hay, straw, and corn knives; and grass hooks. We also draw attention to the "Denio patent" rounded double-end ferrules, and braced back spading forks and manure forks, as combining great strength and durability.

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56. Tubular Barrow and Truck Manufacturing Co., New York, N. Y., U. S.

TUBULAR FRAME IRON WHEELBARROW.

Report.—Commended for strength, lightness, and durability, iron being the only material used in its construction,—tubular for the frame, and sheet iron for the tray; also for good workmanship and cheapness.

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57. Remington Agricultural Co., Ilion, Herkimer County, N. Y., U. S.

NEEDLE COTTON GIN.

Report.—Commended as one of the best machines yet invented for ginning cotton, due to the peculiar form of the cylinder, which, instead of saws, consists of a series of needles with rounded ends, which tear rather than saw off the fibre. These needles are made in small sections, easily renewed, covered with Babbitt metal, which projects slightly beyond the teeth, insuring more intimate contact with the teeth. The Babbitt does not heat, which is a point of considerable importance. The ribs between which the needle circles revolve are slightly chilled at the working parts. The revolving brush, which removes the cotton from the needles, is well made and convenient for repairs. The condenser has also much merit. It comprises a large cylinder covered with perforated zinc, and a small press-roller above. The cotton in passing between these is not condensed and compressed so as to hold together, but weeds, dirt, and dust, etc., find their way through the perforations of the cylinder, and are collected in a spout. The machine can be driven from either side, and all the parts are interchangeable.

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58. Chadborn & Coldwell Manufacturing Co., Newburgh, N. Y., U. S.

LAWN MOWERS.

Report.—Commended for mechanism, material, and finish, great simplicity, and considerable variety. Hand machines made with either two or three blades, to suit the home and English market. Open balance wipers. Merit claimed that as most of the weight is on the periphery, power is accumulated as in a fly-wheel. All bearings bushed with common metal. Bushes can be screwed up to compensate for wear, and are easily replaced at a small cost; handles either rigid or free, castor wheels in front can be taken off if desired. In the horse-power machine four blades are fixed on to flanges, which are so formed as to secure strong attachment and support for the blades. The shaft-bearing is strong. The knife is supported by a strong spring, and adjusted by a set-screw above. Gearings well covered, impossible to clog; driver can throw in or out of gear, but cannot raise the knife.

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59. Peru City Plow Works, Peru, La Salle County, Ill., U. S.

CORN CULTIVATOR (WITH WROUGHT-IRON FRAME).

Report.—Commended for being excellently made, with plenty of crop space under the frame; for the method of adjusting the width of cut by sliding the hoe-frame carriage on the main axles; for the connection of the handles by tie-rods and adjustable screw, so that

they can be made rigid at varying widths or worked separately; for the attachment of the corn-shields by springs to the frame, which allows of their giving in case of serious obstructions; and for reasonable price.

60. Deere & Co., Moline, Ill., U. S.

SINGLE IRON AND WOOD BEAM PLOWS, IRON BEAM GANG AND SULKY PLOWS, AND IRON BEAM-WALKING CULTIVATOR.

Report.—Commended for substantial construction, approved models, and forms for different requirements of service; excellence of material employed, fine workmanship, durability, and uniform high quality of products; reasonable cost to consumers.

61. S. Z. Hall, New London, Conn., U. S.

SELF-FEEDER TO COTTON GIN.

Report.—Commended as an efficient substitute for hand labor, thereby replacing one man; for the peculiar arrangement of the hopper bottom, which contains four revolving wooden rollers, with spaces between, through which dirt, etc., can pass. The cotton is next passed over and round a wooden roller with numerous bars carrying spiked teeth. The frame covering this roller, being of strong wire, allows of dust, etc., blowing away. The cotton is dropped from the roller on to the teeth of the gin.

62. Collins & Co., Hartford, Conn., U. S.

DOUBLE GANG PLOW.

Report.—Commended as a strong, well-made implement, designed for three horses working abreast, one on the right and two on the left side of pole; draft equalized by compensating leverage whipple-trees; draft direct from centre of machine; for strong frame carried on a crank axle; the different angles of the wheel-arms; further alterations by leverage from driver's seat.

63. Skinner & Brother, Des Moines, Iowa, U. S.

PLOWS.

Report.—Commended for excellence of material, good workmanship, and beauty of form.

64. P. K. Dederick & Co., Albany, N. Y., U. S.

PERPETUAL BALING PRESS.

Report.—It is the invention of the exhibitor, and quite original in construction.

It is simple and efficient, forming a very compact bale, of good shape, without undue expenditure of power or severe labor by the operator, and its action is continuous.

The hay is formed into trusses as deposited by the fork, and the bale is thus composed of a series of distinct layers of hay, so that when opened at the end it is easily separated for feeding. No injury is done to the hay by the pressing.

It is portable, and may be readily adjusted to the application of any kind of power.

65. New York Cotton Gin Co., New York, N. Y., U. S.

HAND-POWER COTTON GIN.

Report.—Commended for suitability for the Brazilian market. The machine being compact, easily packed for traveling, can be transported on the back of a mule; important feature for this trade.

66. George W. Brown, Galesburg, Ill., U. S.

CORN PLANTER.

Report—Commended for superior workmanship and durability; the ingenuity displayed in its construction, possessing the desired qualities of lightness of draft, ease, and accuracy in performing the work very cheaply for which it was designed.

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67. Moline Plow Co., Moline, Ill., U. S.

IRON AND WOOD BEAM SINGLE PLOWS, AND WALKING IRON BEAM CULTIVATORS.

Report.—Commended for adaptation to special work, good quality of material employed, solidity of construction, durability, and fine workmanship; reasonable cost to consumers.

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68. C. R. Sargent, Newburyport, Mass., U. S.

HAND SEED PLANTER FOR GARDEN PURPOSES.

Report.—A simple and efficient tool, with good arrangement of change rollers perforated with various-sized holes, according to the nature of the seed to be sown; adjustable row marker, by wheel sliding on axle.

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69. Beardsly Scythe Co., West Winsted, Conn., U. S.

SCYTHES, AND GRASS AND BRIER HOOKS.

Report.—Commended for excellence of workmanship and material, and for general utility.

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70. A. C. Cotton, Vineland, N. J., U. S.

ADJUSTABLE SCUFFLE HOE FOR HAND POWER.

Report.—Commended for varying utility. Can be used as a hoe or scuffle; also for preparing and covering a seed furrow; a good implement for a small farm or garden; made of good material, and well finished; price very reasonable.

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71. Queen of the Harvest Manufacturing Co., West Chazy, Clinton County, N. Y.

GRAIN AND SEED SEPARATOR AND GRADER.

Report.—Commended for the efficient and rapid manner in which the separation of different forms of grain and weed seeds is effected, due to the excellent construction of the hand-made wire sieves, and the varying forms of screens and separators used. The feeder or hopper is detachable, and can be removed when ordinary fanning only is required. This feeder has two screens, one above the other; the one with coarse round openings lets the wheat through and grades larger material; both it and the screen frame have a lateral smooth or trembling motion, according as they vibrate upon smooth or cogged rollers. This is a patented arrangement of considerable merit.

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72. The Hills "Archimedean" Lawn Mower Co., Hartford, Conn., U. S.

LAWN MOWERS.

Report.—A large assortment of well-made machinery of two distinct types:

No. 1, Roller, Archimedean Machine, with large roller behind, securing speed to the knives; noiseless ratchets; adjustable handle, which can be made rigid if desired.

No. 2, Charter Oak Machines. The roller is replaced by two driving wheels, each loose on shaft, and each has a silent ratchet. The advantage of this arrangement is light draft

and ease of turning; cutter-bar and screw shod with steel; cutter-bar easily adjustable by one screw at each end; axle cap can be filed down to take up wear of axle; good bearing and journals; gearing well covered.

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73. J. E. Wisner, Friendship, N. Y., U. S.

HORSE RAKE.

Report.—Commended for the ingenious arrangement for self-action, which is effected by a revolving axle with a toothed wheel in the centre. The boy by lifting a chain with his foot places a lug in gear with the toothed wheel, and the tooth-head rises until the load is discharged, when, coming in contact with a stop-bolt, the teeth return to the ground. The rake frame is connected with the shaft frame by an adjustable lever; pressure on this lever keeps the teeth rigid to the ground. This lever can be used for raising the teeth if required. This rake appears to run very easily.

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74. Richmond Plow Works, Richmond, Ind., U. S.

PLOWS.

Report.—Commended for symmetry of form, durability, and strength, and as being well adapted to plowing in different soils.

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75. The Dunn Edge Tool Co., West Waterville, Maine, U. S.

SCYTHE BLADES, AX HEADS, GRASS HOOKS, AND CORN KNIVES.

Report.—Commended for quality of material, and good workmanship. A new form of corn knife with double edges appears a decided improvement.

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76. Bickford & Huffman, Macedon, N. Y., U. S.

GRAIN AND SEED DRILL (COMBINED).

Report.—Commended for excellence of workmanship, accuracy of delivery, facilities for change of seed from large to small grain, its change of quantity by gear wheels, and regularity of discharge under different conditions. This machine is the same as the "Superior, No. 1," manufactured and exhibited by Thomas, Ludlow, & Rodgers, of Springfield, Ohio, which machine was not tested, one test being regarded as sufficient for both drills, as they differ only in name.

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77. Walter A. Wood, Hoosick Falls, N. Y., U. S.

HARVESTER WITH S. D. LOCKE'S SELF-BINDER ATTACHED.

Report.—Commended for a meritorious accomplishment of a much-needed operation, viz., to apply a self-binding apparatus to a harvesting machine. The reel by which the grain is directed on the traveling apron is very efficient, being adjustable both on its height and forward or backward position to suit the nature of the crops. The tying apparatus is controllable by lock leverage so that the size of the sheaf can be regulated. The wire by which the sheaves are bound is securely twisted, and fastened in one place only. The tension can be altered so as to adapt itself to grain in any condition. Every sheaf is tightly compressed, and when bound is thrown off by one of the compressing arms acting automatically. It is evident that further improvements in details, probably including some simplifying of gearing, is required; but great credit is due to those who have experimented at a large outlay of time and capital.

78. Champion Machine Co., Springfield, Ohio, U. S.

COMBINED SELF-RAKING REAPER (AS A REAPER).

Report.—Commended as a strong, well-built machine, capable of doing good work in both capacities. As a sweep-rake, the gavels were laid with regularity, and the butts of the sheaves well exposed to wind and sun. This is due partly to the table being slightly turned up at the edge. The cam-table and switch-gear are horizontal, automatic, or controllable as desired, being a modification of Johnstone's patent. The platform and knife-bar can be lowered, raised, or tilted by easy adjustment.

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79. Johnson & Gere, Ahwaga Foundry and Agricultural Works, Oswego, Tioga County, N. Y., U. S.

GRAIN DRILL (COMBINED).

Report.—Commended as a strong well-made machine, with attachable manure distributer, strong connection of hoe from standards for shifting, one set moving forwards, while the other goes backwards, securing considerable space for trash. For a good cone-shaped serrated force feed-wheel, which occupies the whole width of the seed-cup, the variation of sowing being secured by change wheels, which our experiments prove to be on the whole more reliable and positive than either an alteration of the force feed-wheel when the latter slides on the shaft, or regulation by opening or closing the outlet of the seed-boxes.

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80. Thomas' Smoothing Harrow Co., Geneva, N. Y., U. S.

HARROWS.

Report.—Commended as a remarkably solid, efficient, and cheap implement, made of excellent material. The main feature of this harrow is that the teeth are put in a slanting position, producing a diagonal cut which facilitates labor and prevents clogging. The harrow may also be used as a weeder with great success.

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81. Sheble & Fisher (Fairmount Fork Works), Philadelphia, Pa., U. S.

HAY AND OTHER FORKS AND STEEL RAKES.

Report.—This is a very large and superior display of hay, spading, and manure forks, dung and potato hooks, made of excellent material, good shapes, and highly finished. The shanks of the steel rakes are particularly well joined to the heads. The forks are strongly made; and in the spading and manure forks special attention has been given to securing strength in the handle by inclosing the lower end holding the shank of the fork with a stout ferrule, having a slotted end, which comes down on and over the top of the blade or head of the fork.

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82. C. Pierpont & Co., New Haven, Conn., U. S.

FODDER CUTTER.

Report.—Commended for direct application of power, the feed-rollers being driven by gearing from the knife-shaft. By altering the size of the pinions four different lengths can be cut. The shaft carries two knives revolving nearly parallel to the face of the box, which is lined with steel, the feed rollers being shielded by a cover which extends back ten inches, and so protects the feeder from risk of accident, which is very important, as there is no means of throwing the rollers out of gear.

83. **The Farmer's Friend Manufacturing Co., Dayton, Ohio, U. S.**

GRAIN AND SEED DRILL.

Report.—Commended for excellence of manufacture and material; for ingenious arrangement of change wheel clustered on a cone so that change of quantity is effected with the greatest ease even while the work is in progress; for force feed-wheel which is slightly concave, having eight zigzag ribs on its surface, filling the seed-box and elevating the grain in a manner highly satisfactory on the level and hillside, but capable of further improvement as regards delivery up and down hill. The bottom of the seed-cup, being hinged, can be opened by removing a pin, and cleaned out. The conductors from the seed-cup to the coulters are removable, and can be replaced by broadcast mouths, thus securing varying utility. The india-rubber springs in connection with the jointed hoe-frames, intended to bring back the hoe into position if thrown back by an obstacle, are well arranged so that during ordinary work no pressure on the rubber is possible.

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84. **Withington, Cooley, & Co., Jackson, Mich., U. S.**

HOES, FORKS, RAKES, POTATO HOOKS, AND CORN AND HAY KNIVES.

Report.—Commended for variety of manufacture, beauty of form, uniform excellence of material employed, fine workmanship and finish, together with reasonable strength and solidity of the several parts.

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85. **Rhodes & Waters, Elyria, Ohio, U. S.**

EUREKA POST-HOLE DIGGER.

Report.—Commended as a strong, efficient implement, well adapted for holing in strong as well as light soils. The judges saw it worked on a hard road. The ease with which the disturbed soil is removed by spreading the handles renders it a valuable labor-saving implement well deserving recognition.

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86. **John H. Thomas & Sons, Springfield, Ohio, U. S.**

HORSE RAKE.

Report.—Commended for simplicity of construction, the weight of the driver being so utilized that the additional pressure of the load upon the rakes overcomes the balance and elevates the teeth. The wheel axles are broken, passing through eyes bolted to the under side of the frame, thus securing a perfectly independent action to the frame. The teeth are firmly secured, and easily taken out in case of breakage, by the removal of one nut; over the head of each tooth is a brass spring which insures clean raking. The teeth have large capacity, the cleaner-bar being placed outside the teeth when the latter are down. Price reasonable.

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87. **George W. Rue, Hamilton, Ohio, U. S.**

POTATO DIGGER, HAND CULTIVATOR, AND COMBINATION HAND HOE.

Report.—The potato digger is effective and reasonable in price, and is provided with a rolling fender on the beam, lessening the liability to choke.

The hand cultivator is light, adjustable, easily managed, and efficient.

The combination hand hoe is a convenient tool, with the shank and blades so constructed that any shaped blade may be easily attached.

88. I. Sedgebeer & Miller, Painesville, Ohio, U. S.

NONPAREIL FARMERS' FEED AND CORN MILL.

Report.—Commended for the peculiar construction of the metal grinding surfaces, which consist of a series of Y-shaped projections, flat and smooth on the face, so that contact does not injure the mill. The mill comprises first a small breaking machine, which reduces the grain and prepares it for the vertical disk wheels, which are made of gray iron and covered with Y-shaped projections in alternate sections, which can be ground down by emery to a fine surface. These plates can be cheaply renewed. The mill is run at about eight hundred to two thousand revolutions a minute, and works equally well reversed.

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89. Samuel Fisher, Philadelphia, Pa., U. S.

WHEEL GANG PLOW WITH CULTIVATOR.

Report.—Commended for utility as a wheel gang plow and cultivator, simple in construction. The four iron beams between the wheels are ingeniously arranged for the attachment of shovel or turning plow, as required, by means of a bolt. The beams work on hinges independently of each other, enabling the plows to follow the uneven surface. The plows are elevated and lowered by two levers, one on either side of the driver's seat.

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90. A. J. Nellis, Pittsburg, Pa., U. S.

HARPOON HORSE HAY FORK AND GRAPPLES.

Report.—Commended for the rapidity with which hay can be unloaded and carried up by the draft of the horse acting through pulley-blocks. The fork comprises a single standard with double harpoons, which are actuated by a lever, and effectually hold up the load while it is being elevated. Also for ingenious mechanism of grappling blocks, which are so constructed that they can be elevated on a pole to the required position, fixed to the beam by claws, and held fast, and removed with equal facility.

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91. The Hall Husking Glove Co., Chicago, Ill., U. S.

HUSKING GLOVES AND PINS.

Report.—Commended for strength of material and durability of wear. The material is strong tanned calf-skin, protected with steel plates. The right-hand glove is furnished with a strong steel husking pin, or claw, by which the husk is principally removed. Half gloves are made on the same plan, and present certain advantages by half the cost. The hands are kept cooler and have more freedom.

The husking pins are also sold separately with straps to fasten to the hand.

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92. Gale Manufacturing Co., Albion, Mich., U. S.

HORSE HAY RAKE.

Report.—Commended for a well-constructed rake, simple in design, having an improved clearing-bar and means of adjustment for changing the position of the lever and the position of the rake-head.

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93. P. P. Mast & Co., Springfield, Ohio, U. S.

CORN CULTIVATORS.

Report.—Commended for varying utility, being equally adapted for riding or walking. Having high wheels and a light, though strong, well-braced wooden frame, the draft is reasonable. The wheel-axles, which are cranked, are strongly attached to the frame; frame raised out of work by foot lever, treadle, and chain. Corn guards consist of rotating

toothed wheels, which are very efficient. Standard arm jointed to frames, braced by iron band, to which wooden pin is attached, so that in the event of an obstruction breaking the pin, the whole arm, and not the hoe only, flies back, rendering breakage impossible.

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94. Bickford & Huffman, Macedon, N. Y., U. S.

FERTILIZING ATTACHMENT TO GRAIN DRILL.

Report.—Commended for a successful distribution of artificial fertilizers, due to the peculiar form and action of the stirrers, which consist of revolving star-shaped disks, which run on the bottom of the hopper and bring the manure over diagonal openings, which are regulated by a slide attachment, giving great variability.

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95. Furst & Bradley Manufacturing Co., Chicago, Ill., U. S.

SINGLE GANG AND SULKY PLOWS, CULTIVATOR, AND HORSE RAKE.

Report.—Commended for extent and variety of manufacture, uniform good quality of products in material, workmanship, and adaptation to the special service required of each, reasonable simplicity of construction, and lightness consistent with durability, facility of handling, and thorough work; moderate prices to consumers.

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96. Vandiver Corn Planter Co., Quincy, Ill., U. S.

VANDIVER CORN PLANTER.

Report.—Commended as well constructed, of good material, reasonably light, and durable; delivers the grain accurately in sight of the driver, and covers it well in all properly prepared soils to secure uniform germination.

It is simple in construction, easily adjusted, and may be readily converted into a drill by drill attachment, for which the frame is prepared by the manufacturers.

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97. South Bend Iron Works, South Bend, Ind., U. S.

CHILLED PLOWS AND ATTACHMENTS.

Report.—Commended for the highly-tempered metal used in its construction, and the ingenuity displayed in giving it shape and finish to suit it to different soils; for making it cheap and very durable, and overcoming the heavy friction against the land side by placing the beam over the centre of the plow.

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98. Smith Harper, Philadelphia, Pa., U. S.

GARDEN AND FIELD HAND HOES, AND GARDEN, LAWN, AND FIELD HAND RAKES.

Report.—Commended as embracing a large and varied assortment of the manual implements named; of uniform good quality, fine finish, and substantial workmanship; light and durable in construction and material, and well adapted to their several uses.

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99. B. F. Avery & Son, Louisville, Ky., U. S.

PLOWS, WALKING CULTIVATORS, AND SULKY PLOWS.

Report.—Commended as of the best material, of the most approved patterns, and thoroughly finished.

The walking cultivator is commendable for the same reasons, and for the form and strength of the frame.

The sulky plow has a novel arrangement in the plow being placed forward of the axle and driver's seat.

100. James Selby & Co., Peoria, Ill., U. S.

CORN PLANTER.

Report.—Commended as a strong, well-made machine, with foot leverage for raising the seed-boxes, and an arrangement to regulate the depth of planting, and for rigidity of coulters; seed slide-bar travels on friction rollers, secures great freedom of motion; boy's seat adjustable so that weight can be brought right on to the shoes or runners. A small stirrer in the seed-hopper keeps the grain well up to the openings; good foot leverage for wheel scrapers.

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101. D. E. McSherry & Co., Dayton, Ohio, U. S.

RICE DRILL AND GRAIN AND SMALL SEED DRILL.

Report.—The rice drill is commended for the admirable action of the force-feed, which is on the same plan as that used in the grain drills of this firm, insuring very even discharge both in the level and the hillside.

This drill has four hoes, fifteen or sixteen inches apart, which have wide mouths, in order that the rice may be sown in a broad channel. The patent lift-bar is used.

The grain and small seed drill is commended for the excellence of manufacture and material for the nature of the force-feed arrangement, which comprises a spiral ribbed wheel with a spring washer attachment, which prevents the grain being crushed. This wheel and washer occupy the whole transverse span in the seed-cup, which insures regularity of delivery on hillsides. Some farther adjustant appears desirable to enable this drill to deliver with equal equality of delivery up and down hill. For the way in which the alternate hoe frames are hung on an iron rod which slides forward or backward in strong grooves. For a patent lift-bar.

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102. A. B. Farquhar, York, Pa., U. S.

COTTON CULTIVATOR.

Report.—Commended for its simple and strong construction. It does the work economically and facilitates subsequent operations. The improvement of this machine consists of two S-shaped knives which revolve horizontally, chopping everything in their way, leaving at distances diamond-shaped groups.

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103. A. B. Farquhar, York, Pa., U. S.

PLOW.

Report.—Commended for the strong combination standard; for its attachment to the beam by one bolt behind and adjustable clip in front; for the arrangement by which the land side and sole can be adjusted to compensate for the wearing away of the share, and for the facility with which the implement can be converted into a cultivator, hoe, or double-earthing plow; a number of different points being supplied for these objects, and included in the price, which is reasonable. The importance of a good convertible implement as tending to utility, especially for small occupations, commends this implement.

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104. A. B. Farquhar, York, Pa., U. S.

MACHINE FOR SEPARATING RICE FROM ITS STRAW.

Report.—Commended for great strength, simplicity of construction, efficiency, and for the following specialties: peculiar form of drum and concave teeth, which have rounded backs and beveled edges, in order to avoid breaking the grain; for vibrating carrier, composed of ribbed sheet iron, with three projecting notched wood pieces with open spaces for the passage of the rice to the screen of the winnower; for three cross bars, with agi-

tating teeth adjustable, which heip to retard the passage of the straw and shake out the grain; for adjustable riddle to regulate the discharge of any unthrashed ears; and for a measuring hopper and simple counter.

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105. S. R. Nye, Winchendon, Mass., U. S.

HORSE HAY RAKE (BAY STATE RAKE).

Report.—Commended for the facility with which the rakes rise and discharge the load. This is effected by replaceable ratchets on both wheels; the frame is connected at will with these ratchets by means of a trip worked by foot levers. The teeth increase in spread to the centre, and so form the parabola of a circle. We could not see that this peculiarity was advantageous, as it reduces the capacity of the rake, the hay taken up at the outside being unduly pressed. The clearers are high, and do not materially interfere with the capacity of the rake. The workmanship and material appear excellent.

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106. George Esterly & Son, Whitewater, Wisconsin, U. S.

BROADCAST DISTRIBUTER AND HOE ATTACHMENT.

Report.—It is a useful combination of a broadcast machine of large capacity, with a hoe frame which covers the seed as sown, or can be used as a corn hoe. The frame hangs on a vertical bar having considerable freedom; can be guided with accuracy by means of two handles, which give a powerful leverage. Force-feed comprises a fluted wheel which slides on shaft by lever adjustment. Quantity distributed depends on proportions of fluted wheel in the seed-box. This is probably not a very accurate adjustment. Seed falls upon an inverted cone with projecting rays, which insures spread. The hoe standards are attached to the frame in such a manner as to be adjustable as to pitch.

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107. Silver & Deming Manufacturing Co., Salem, Ohio, U. S.

STRAW AND STALK CUTTER.

Report.—Commended for a safety fly-wheel arrangement, the wheel being fixed to the shaft by a friction cone. In the event of iron or other hard substances getting into the feed, the fly-wheel revolves but the knife stops. Also for a simple plan of changing the cut by shifting cluster of gear wheels.

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108. Keystone Manufacturing Co., Sterling, Ill., U. S.

TWO-HORSE CORN PLANTER.

Report.—Commended for the two following merits: 1, for regularity of the cut-off; 2, for the adjustable shoe under side of coulter, which regulates depth at which seeds are deposited.

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109. George Griffiths, Philadelphia, Pa., U. S.

SPADES AND SHOVELS.

Report.—Commended for variety of useful forms, for strength and quality of material and workmanship, and for reasonable prices.

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110. T. Rowland & Sons, Philadelphia, Pa., U. S

SHOVELS AND SPADES.

Report.—Commended for excellence of material and superior workmanship, and for their adaptation to the work for which they were designed.

111. Pennock Manufacturing Co., Kennett Square, Chester County, Pa., U. S.

DOUBLE HARPOON HORSE HAY FORK.

Report.—Commended for great capacity, and special adaptation for dealing with short hay, and for cleaning up the last portions of the load.

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112. S. Hanck & Brother, Lebanon, Pa., U. S.

CABBAGE CUTTER.

Report.—Commended for simplicity of construction, efficiency of work, and adjustability.

1. Lightning cutter; comprises a stationery hopper and vibrating table, with double-edged knife cutting both ways. The power is applied through a heavy fly-wheel; a smaller wheel on same axis actuates the table by means of a pin on its periphery working in an upright slot, to which the table is attached. We thus have a remarkably easy motion. The cabbage or other vegetable is pressed down by a follower, which can also be used as a divider for the hopper. Useful for small vegetables.

2. Centennial. This is a much cheaper machine, but less efficient. The cutter-bar is fixed. The hopper-box, on friction wheels, is worked backwards and forwards by hand, running on tracks of galvanized iron. Gun stocks at either end arrest the traverse of the box beyond the requisite limits. These machines are principally valuable in the preparation of sourkrout.

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113. Clegg, Wood, & Co., Dayton, Ohio, U. S.

ARCHER HORSE RAKE.

Report.—Commended as a well-made and efficient horse rake, which can be raised or lowered vertically. Driver's seat adjustable according to size of attendant. Teeth set well under the machine. The teeth frame is hinged at top of axle; gives considerable space for load.

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114. A. J. Nellis & Co., Pittsburg, Pa., U. S.

IRON TIE FOR BALING COTTON.

Report.—Commended for simplicity, strength, ease of adjustment, and impossibility of loosing the buckle or tie in transporting. The exhibitors have two kinds of tie, of equal merit.

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115. Oliver Ames & Sons Corporation, North Easton, Mass., U. S.

SHOVELS AND SPADES.

Report.—The shovels and spades are made from the best materials, an l of a very superior finish.

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116. Haworth Planter Co., London, Ohio, U. S.

CHECK ROWER FOR PLANTING CORN.

Report.—Commended for an ingenious arrangement, applicable to any corn planter, by which the seed-slide can be made to work at the required intervals, and the boy usually employed to work the slide is dispensed with. The action is secured by means of a rope fixed at either end of the field, which passes over and around pulleys fixed to the planter. The rope is knotted at proper intervals; as the machine passes these knots the required action of the seed-slide takes place.

117. B. D. Buford & Co., Rock Island, Ill., U. S.

GANG PLOWS, WALKING CULTIVATORS, SULKY PLOWS, AND IRON AND WOOD BEAM SINGLE PLOWS.

Report.—Commended for variety of manufacture; good quality of products; adaptation of the several implements to special work required of each; material, workmanship, durability; and for reasonable cost to consumers.

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118. O'Brien Brothers Manufacturing Co., Kewanee, Henry County, Ill., U. S.

VIBRATING HARROW.

Report.—Commended for ingenious construction and light draft. The harrow is made in three sections, which are attached in such a manner as to secure a perfectly independent action and allow of adaptation to uneven ground.

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119. Wheeler & Melick Co., Albany, N. Y., U. S.

HORSE HAY RAKE.

Report.—Commended for simple and effective method of raising the teeth and discharging the load. Revolving axle, connected with the wheel by linch-pins, is divided in the centre. Friction bands, tightened by a lever and chain, effect the required motion. This rake has considerable capacity, owing to the fact that the cleaners are placed tolerably high and do not interfere with the accumulation of the hay in the rake.

A second machine shown by this firm is commendable for the mode of attaching the draft. The horse draws by traces from a bodkin which is attached to the lever; consequently, when the lever is set free to act by pressure of the workman's foot, the horse greatly assists in the operation of dumping. The rakes are hung upon a bar by collars. They have considerable freedom of motion, and the machine is well made, simple in construction, and fairly efficient.

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120. D. Root, Son, & Co., Mount Joy, Pa., U. S.

CULTIVATORS.

Report.—The cultivators are well made, of a desirable pattern, iron frames, expanding sides, and with a wheel in front, adjustable to regulate the depth of work.

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121. Joseph Rothchild, Shelbyville, Ky., U. S.

CHECK ROW CORN PLANTER.

Report.—Commended for ingenious arrangement by which the grain can be dropped automatically at the requisite distances. Each half revolution of the wheel causes a cam to actuate the dropper; two disks standing out from the periphery of the wheel mark the places in a line with which corn drops, and thus act as track markers. The wheel axle can be raised or lowered by lever handle. The wheels have a series of spokes on the surface. If the wheel disk does not return in the holes made by the previous run, and consequently the seeding is out of line, then by raising or lowering the wheel ground is gained or lost as required. A heavy marker carried on a spring at the end of frame acts as an assistant guide; frame easily raised by a foot lever.

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122. Russell, Burdsall, & Ward, Port Chester, N. Y., U. S.

BOLTS AND NUTS FOR USE IN CONSTRUCTION OF AGRICULTURAL IMPLEMENTS AND MACHINERY.

Report.—Commended for the uniform good quality and reasonable cost of the products.

123. Gregg & Co., Trumansburg, N. Y., U. S.

SULKY PLOW.

Report.—Commended for solid, simple, and ingenious construction, and comparatively low price. Any right-hand plow may be attached to the frame, giving the advantage to use this plow in any class of soil. The axle is adjustable, so that the plow may be handled very easily, and the contrivance for varying the depth is so complete that the driver may do it instantaneously.

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124. A. B. Travis, Brandon, Oakland County, Mich., U. S.

WHEAT HOE AND BROADCAST SOWING MACHINE.

Report.—Commended for a combination which effects two important operations, viz., to sow grain broadcast and cover the seed by means of a series of hoes attached to a pivoted frame with handle. The same implement is an efficient hoe for drilled grain, the workman being able to steer the frame with great nicety. The seed distribution is effected by means of reciprocating slides with holes of different sizes driven by cam gearing on inside of driving wheels; different-shaped hoes can be attached.

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125. Brown, Hinman, & Co., Columbus, Ohio, U. S.

HOES AND FORKS.

Report.—Commended for good material and workmanship, for variety of utility, for a capital collection of socket and shank hoes of various forms and for different purposes. Also for scythe cradles with regulating screws, allowing of adjustment to suit workmen.

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126. P. P. Mast & Co., Springfield, Ohio, U. S.

BUCKEYE PLOW SULKY.

Report.—Commended as a convenient carriage to which any ordinary two- or three-horse plow, wood or iron beam, right- or left-handed, may be readily attached, the whole forming a sulky plow. The devices to secure proper adjustability as to direction and depth are ingenious, novel, and efficient. The frame is strong and durable.

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127. Nash & Brother, New York, N. Y., U. S.

POTATO PLANTER.

Report.—Commended as an ingenious invention, and, provided it is a fact, as declared by the exhibitor, that potatoes sliced into wedge-shaped sections will grow whether such sections have eyes or not, effective. The hopper consists of a round iron box with revolving bottom, furnished with eight openings four inches in diameter, which can be reduced by bushing rings to two and one-quarter inches, and any of them can be covered by a shield so as to cease acting; over the discharge opening below is a stationary horizontal knife with an opening of three-fourths inch on one side, one-eighth inch on the other, securing a wedge-shaped cut; a second box, which can be removed if desired, sows fertilizers, which can either be dropped at same point as the sets, or at intermediate intervals. The distributing power consists of a horizontal scraper; a ratchet and spring in wheel throws in and out of gear and stops delivery while turning.

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128. Moses Johnson, Lockport, N. Y., U. S.

PATENT ROTATING HAND WEEDER AND HAND HOE.

Report.—The rotating weeder is commended for the varying operations to which it can be applied. This is due to a revolving spindle which carries four sorts of cuts. The

spindle is turned by the foot and held in place by a ratchet and spring. The cutters can work at any angle and at different depths.

The cultivator or hand hoe is commended for excellence of material and ingenuity displayed in constructing, with little cost, hoe and socket out of same piece of steel without weld or rivet. The front of socket is concaved, imparting greater strength to the very light hoe.

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129. Marsh Harvester Manufacturing Co., Sycamore, Ill., U. S.

WIND VANE PUMPING ENGINE.

Report.—Commended for the highly ingenious arrangement by which the length of stroke of the pump is adjustable according to the force of the wind, and for the sensitive action of the fans, which open out to the wind, being actuated by a spring on the shaft and levers. The engine runs equally well with a light or a heavy wind. Price reasonable.

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130. The J. C. Hoadley Co., Lawrence, Mass., U. S.

PORTABLE FARM ENGINE.

Report.—Commended for peculiar arrangement of steam jacketed cylinder, the steam being admitted into the jacket direct from the boiler, the jacket acting as a dome; also for the capacity and construction of the boiler. These two points are considered meritorious; but the general construction of the engine is not approved of, considered as a farm engine, and no opinion is offered as to the value of an automatic cut-off on main shaft in place of ordinary governors.

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131. The Eclipse Windmill Co., Beloit, Wis., U. S.

WIND ENGINE.

Report.—Commended as a thoroughly efficient, well-made engine, economical in work. We find a strong solid wheel varying in size from ten feet to sixteen feet diameter. The special claim is for a small controllable side vane, which acts as an overbalance and draws the sail away from the wind in a storm. It is prevented from acting unfavorably in a light wind, because it must first overcome the leverage of a weighted arm, which can be made adjustable by moving the weight nearer or farther from the centre. The turn-table travels on four friction balls running on a grooved surface. Table casting is made in one piece with the cap or bed plate, and has flanges on under side to receive the heads of the posts. The end of the piston-rod has a ball attachment which keeps it in place. There is no method for taking up the wear of this ball.

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132. Tappey & Steel, Pellsburg, Va., U. S.

BEASLEY'S POWER BALING PRESS.

Report.—Commended for simplicity and rapidity of action, all motions derived from one belt. The motion of the press is arrested automatically at the proper point, and the action of the screw is reversed by a lever. A well-made, strong, and efficient machine.

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133. The Brown Cotton Gin Co., New London, Conn., U. S.

POWER COTTON GIN.

Report.—Commended for general excellence of construction and design, comprising a very efficient machine, with all labor-saving appliances. Thus, we find a self-feeder, differing from others principally in the fact that the hopper bottom has a series of fixed and movable bars with iron serrated teeth set about one-eighth of an inch above their surface.

These convey the cotton with considerable regularity on to a revolving spiked feeder, by which it is carried to the saws. This feeder is inclosed in a wire cover. The saws work through flat ribs according to the usual plan, but the peculiar arrangement is that the ribs are adjusted to the saws by means of external screws. The condenser is not so good as it might be; the perforated cylinder being above the press roller, there is not the opportunity for the escape of dust, etc., as if their positions were reversed. Also commended for moderate draft due to simplicity of the gearing.

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134. R. Wakeman, Port Deposit, Md., U. S.

HAY AND COTTON PRESS (BY HAND POWER).

Report.—Commended for powerful and rapid leverage, effected by ratchet, lever, and pulley. The chain winds upon a cone cylinder so arranged that the power increases as the presser works home. Each leverage exercises a pressure of fourteen tons. In present form this machine is adapted for hay, but can be made equally suitable for cotton by slight modifications of the press.

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135. Chandler & Taylor, Indianapolis, Ind., U. S.

PORTABLE FARM ENGINE.

Report.—Commended as a well-made, light-running engine; boiler space somewhat limited, consequently this is not a specially economical machine. The steam is taken from the dome of the boiler by pipe passing into and through the boiler to the smoke-box, where the pipe coils so that the steam becomes superheated and enters the chest without exposure to the air in a dry condition. This appears a meritorious arrangement. The cylinder is jacketed with felt. The steam-chest is placed below the cylinder, so that all condensation is clear of the cylinder. The piston valve is balanced. The guides have large surfaces. All connecting rods are of steel. The pump has a three-way valve, spring seat for driver, brake on hind wheels acted on by leverage from driver's seat. The boiler is connected with the centre of fore carriage by ball-and-socket joint.

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136. Best Steam Engine and Boiler Works, Lancaster, Pa., U. S.

PORTABLE FARM ENGINE.

Report.—Commended as a practical useful engine suitable for agricultural work. The pillar blocks are on one saddle, which is bolted to the bed plate; feed-water pipe of pump passes through pillar block journals, and this keeps them cool. Pump rod very direct. A double valve shuts off water from the boiler, and opens a valve which conducts to ash-pan, an excellent arrangement, preventing accidents to pump. Simple plan for reversing the eccentrics without link. The connecting rod has solid ends, boxes set up by key adjusted by set-screw. Water heater consists of a screw, steam passes right through the centre. The crank axle with iron springs.

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137. C. H. Dana, West Lebanon, N. H., U. S.

LABELING MACHINE.

Report.—Commended for highly ingenious mechanism, by which wire labels for cattle, hogs, or sheep are stamped with name or initials, numbered from 0 to 1000, cut and ring-shaped, suitable for insertion in the ear; ease with which the work can be done by a lad, and rapidity of execution; one thousand labels can be made in twenty minutes. Immense saving in labor over hand work.

138. Mansfield Machine Works, Mansfield, Ohio, U. S.

PORTABLE FARM ENGINE.

Report.—Commended for comparatively large boiler capacity; good pump with air chamber, driven by eccentric from main shaft. The engine is attached to the side of the boiler in a convenient position for oiling, etc.; carried on a strong well-arranged bed plate, which can be detached from its brackets and used as a stationary engine. Cylinder has a steam jacket, joints scraped or ground, no packing used, adjustable cut-off, sliding throttle valve, readily fixed at any desired point, balance steam valve, steel fire-box and steel flue sheet, small water heater with return pipes. Altogether, a well-balanced, well-arranged, and carefully-finished machine, likely to do good duty.

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139. E. Stover & Brother, Freeport, Ill., U. S.

WIND ENGINE.

Report.—Commended as a strong durable engine, not liable to get out of order, for the following reasons. The wheel is solid, dished inwards, which allows of the fellies, which are round, acting as braces. The vane beam has a spring clutch which acts on the crank wheel of the pump and instantaneously stops the motion. The turn-table runs on an anti-friction table, comprising sixteen chilled iron balls, making the action sensitive and allowing of a comparatively short vane being used. The shaft castings are long and divided into two parts with india-rubber between, to compensate for wear. In storms the wheel luffs because the wind overcomes a weight on the left side of the machine. The frame is made of four pieces of timber bolted together near the top: this makes a strong connection.

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140. United States Wind Engine and Pump Co., Batavia, Ill., U. S.

WIND ENGINES.

Report.—Commended for the powerful and efficient wind engines, with sectional sails, turning on a transverse axis and capable of being set with their edges to the wind, in which position the mill stops. These sails are held to the wind by an adjustable weighted lever ingeniously connecting with radiating arms attached by jointed levers to the transverse axis of each section. Each arm is provided at its extremity with a weight: when the centrifugal tendency of these weights is sufficient to overcome the weighted lever already described, their action causes the sections to turn their edges to the wind more or less completely, according to their velocity or the force of the wind, so that in a stiff breeze the position of the section is almost parallel to the direction of the wind, and the least amount of surface is exposed that will keep the mill to its work. The only objection that we know of to these mills relates to complication of parts, requiring the frequent lubricating of many joints, and high original cost.

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141. Frick & Co., Waynesboro, Pa., U. S.

PORTABLE FARM ENGINE ("ECLIPSE").

Report.—Commended as an engine giving the best results of any that were tested, and may be regarded as a well-made, strong, useful machine. The traveling wheels are large and powerful. The boiler is suspended on springs for traveling, which are let down when at work. The boiler is capacious. There is a powerful brake on the hind wheels, very useful for staying the engine when at work. The engine is carried on the top of the boiler, resting on a powerful bed plate, which is hollowed out to form a receptacle for oil leakage. This can be detached from the brackets and the engine converted into a fixed horizontal engine if required. The governor has three speeds, and the crank shaft is counterbalanced. The engine saddle has provision for varying expansion.

The water heater is large, of the ordinary diaphragm form, and the pump with air cham-

ber is well constructed. The cylinder has balanced slide valves. The safety valve works by a spring, which is a good arrangement, particularly when the roads are rough. Driving wheel on each side of crank shaft.

142. Jona Bigelow & Co., Boston, Mass., U. S.

PATENT LABELING MACHINE.

Report.—Commended as a most ingenious, efficient, and labor-saving invention for attaching labels to cans or bottles. The apparatus comprises an inclined plane, with a paste-roller at the upper end, covered with flannel, and working in a paste-box. The labels are placed in a recess lower down, which is so arranged that the bottom rises as the labels are withdrawn, thus insuring that as the pasted surface of the can passes, the label shall be attached. The most ingenious part of the performance is the way in which the edge of the label is gummed. This is effected by the can, after picking up its label, passing over and pressing down an upright lever, which, by a cam gear, causes a brush to rise and gum the top label ready for the next can. All that is required is to start the can or bottle rolling down the inclined plane. The label is picked up and perfectly fastened. The saving of labor over hand work is very great.

143. Elias Stangeland, Rockdale, Minn., U. S.

FEED STEAMER.

Report.—Commended for its efficiency and simplicity as a very economical farm apparatus, simply consisting of a boiler and tub, in which the feed is cooked by means of steam.

144. Kenosha Fanning Mill Co., Kenosha, Wis., U. S.

FANNING MILL.

Report.—Commended for good workmanship in make and finish. The motion is easily adjusted to any required shake by means of cams with a hook that is shifted to holes in shaker, thus procuring the desired motion to sieves. Also for its utility as a grain separator.

145. Pittsfield Eureka Fan Mill Manufacturing Co., Pittsfield, Ill., U. S.

FANNING MILL.

Report.—Commended for its value as an efficient and rapid grain cleaner and separator, the sieves are easily changed and adjusted to suit the various kinds of seeds, and for cheapness and durability.

146. Barnard Cortrite, Norwalk, Ohio, U. S.

EUREKA FANNING MILL.

Report.—Commended as a well-made, strong, and efficient winnowing machine, a separator capable of separating clover and plantain, timothy and grain, and all sorts of seed weeds, making superior samples, light-running, with adjustable blast, regulating shaker, and a great variety of admirably-made screens for various purposes. Moderate cost.

147. Russell & Co., Massillon, Ohio, U. S.

EIGHT-HORSE POWER THRASHING MACHINE.

Report.—Commended for quality of material and workmanship, capacity for rapid and efficient execution, especially provided for by the presence of the winnowing fans, which improve and simplify the separation of chaff from the grain; for the mode of driving the riddles by pitman from lower fan shaft; for attachment of straw elevator; and for convenient plan of folding up.

148. J. I. Case & Co., Racine, Wis., U. S.

TEN-HORSE POWER THRASHING MACHINE.

Report.—Commended as a strong, well-made machine, capable of doing efficient work, and reasonable in price; also for capacity and general satisfactory work.

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149. Keystone Manufacturing Co., Sterling, Ill., U. S.

HAND CORN SHELLER.

Report.—Commended for being thoroughly well made and efficient; for possessing a feed hopper, which facilitates feeding, allowing a boy to operate as effectively as a man without it; for having a powerful winnowing fan, which removes chaff, etc.; for heavy fly wheel, which gives steadiness to the mill, and reduces the labor of working; and for utility for small occupations.

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150. Wheeler & Melick Co., Albany, N. Y., U. S.

STRAW PRESERVING RYE THRASHER.

Report.—Commended for special arrangement of concave on springs, allowing of considerable variation in case of a large quantity of straw passing the drum; and for the arrangement of the drum beaters securing desired effect.

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151. Jos. K. Mount & Co., Hightstown, N. J., U. S.

CHAMPION HAY CONVEYER.

Report.—Commended for simplicity of construction, strength and ease of motion, secured by having four friction rollers. While the load is being made and raised, the conveyer is secured in position by a lock lever; the pulley wheel or ring of the fork striking a rod in connection unlocks the lever, and the strain of the rope, actuated by the power below, immediately causes the conveyer to travel along the rail to any required point, when the load is discharged. This is a most desirable addition to the ordinary unloading fork, which, without such assistance, must discharge the load only at a given point, from whence it must be removed by manual labor. With this, no matter what is the size of the barn, one man, or a man and a lad or girl, can shake up and stack the hay as fast as it can be elevated. The conveyer well braced, and a guide from lower side of the lever prevents the rope getting off the pulley. No injury can be done to the roof by the rail, since the latter is secured to the rafters in such a manner by clips as tends rather to truss the roof than otherwise.

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152. Warder, Mitchell, & Co., Springfield, Ohio, U. S.

CHAMPION SELF-RAKING REAPER.

Report.—A strong, well-made machine, on the same principle as the Champion machines, differing slightly in some of the minor details; thus, the rake gear cams are placed vertically with flanges. The cam gear is placed nearer the table. The rakes act in a nearly parallel direction above the knife, securing a level deposition of grain on the table, and well-made, tidy gavels.

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153. Thomas Hazard, Wilmington, Ohio, U. S.

CHAFF CUTTER (KEYSTONE COMMON SENSE).

Report.—Commended for an ingenious arrangement of steel springs in front of mouth which steadies the knife and holds the straw while it is being cut off. The upper edge of spring comes in front of the material that is being cut, and prevents a ragged tearing action. Also for the manner in which the speed of the upper feed roller is regulated, and consequently the change of cut effected, which is done without change of wheels.

154. Stuart Perry, Newport, N. Y., U. S.

HAY TEDDER.

Report.—Commended for simplicity of gearing, great power, and the admirable way in which the grass is kicked up and left exposed to sun and wind. The revolution of the tines is effected by a cam gear, so contrived that after the work is effected the tines rise up from the crop, rendering clogging or undue agitation impossible. The tines are made self-adjustable by a spring. The shafts, two in number, are driven from both wheels; they are made of hollow gas-piping, strong and durable.

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155. John A. Hafner, Pittsburg, Pa., U. S.

COIL SPRINGS FOR THRASHING MACHINES.

Report.—Commended as a valuable addition to thrashing machines driven by gearing from horse or steam power, but especially the former, acting as a reservoir or accumulator of power, preventing the sudden jerks incidental to the starting of the horses or the choking of the cylinder, saving the horses' shoulders from injury, and steadying the motion materially. The spring is so constructed that its durability is securéd. The application is easy.

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156. The Pitts Agricultural Works, Buffalo, N. Y., U. S.

THRASHING MACHINE (STEAM OR HORSE POWER).

Report.—Commended for the method of attaching the draft-poles, which secures strength and allows of considerable play; and for strength of horse gears generally; for the arrangement of the thrashing machine, which is well balanced, strongly braced, and efficient, doing good work, and being of the largest class in point of capacity.

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157. Stratton & Cullum, Meadville, Pa., U. S.

HAY LOADER (FOUST'S).

Report.—Commended as a most efficient labor-saving machine, picking up and elevating hay or loose grain out of windrows into the wagon as rapidly as could be done by four men; and for simplicity of construction and admirable adaptability for the work. The machine consists of a revolving frame on high wheels with curved tines which pick up the hay and place it on the elevator, composed of traveling chains carrying cross-bars of wood, with a slatted wind guard which materially assists the elevating process. To the revolving frame are hinged hammers, which, striking against fixed surfaces, give the hay a shake and facilitate the delivery from the collector to the elevator. The attachment to the wagon is by a hook, which allows of the junction being made or severed with the greatest ease. The machine can be thrown out of gear for traveling.

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158. Sandwich Manufacturing Co., Sandwich, Ill., U. S.

SELF-FEEDING POWER CORN SHELLERS (ADAMS PATENT).

Report.—1. Commended for machines representing a large and successful industry in the heart of, and adapted to the wants of, the great corn (maize) producing district of the United States of America.

2. They are substantially constructed, and reasonable in cost to consumers.

3. Being "picker wheel" machines, they separate the grains from the cob with the minimum amount of injury to either cob or grains consistent with clean, thorough, and rapid work.

4. The devices and attachments for self-feeding, insuring regularity and certainty of feeding, as also to supply the necessary pressure without clogging, and to render easy the adjustability to different positions and application of power, are ingenious and effective.

5. They are economical of power compared with the work accomplished.

159. Treman, Valentine, & Green, Ithaca, N. Y., U. S.

HAND CORN SHELLER.

Report.—Commended for strength of construction, simplicity, and efficiency, separating the corn from the cob by double feed, and also separating chaff, etc., from the grain and cobs by small winnower.

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160. Huber Manufacturing Co., Marion, Ohio, U. S.

REVOLVING RAKE AND HAY COLLECTOR.

Report.—Commended for the improvements over the old collectors, viz., working on iron and being held in position by an iron spring; also for a jointed arrangement which allows of its being folded up and readily transported. The action of the spring, aided by the intelligence of the operator, secures the operating teeth being kept at a proper angle. The handles are kept rigid by a tie rod. They are connected to the frame by a secure bearing. Though hardly a hay rake in the proper sense, as it cannot rake uneven land clean, it is very useful for cutting hay into rows with rapidity, and has one great merit, viz., low price.

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161. J. R. Fitzhugh, Philadelphia, Pa., U. S.

HAY ELEVATOR.

Report.—Commended on account of its simplicity and its cheapness. This is a traveling pulley running on a bar and intended to be attached to a hay fork for the purpose of unloading hay or straw from a wagon; when the load reaches the desired point it is stripped by a cord and the load is discharged from the fork, and the device and fork are returned over the wagon by a weight.

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162. D. M. Osborne & Co., Auburn, N. Y., U. S.

HARVESTER AND AUTOMATIC BINDER.

Report.—Commended as a highly successful attempt to introduce a much-wanted labor-saving harvester. The mechanism by which the binding is effected with wire is simple and efficient, as proved by the fact that during a somewhat protracted trial there was no failure or stoppage. The sheaves can be regulated as to size by foot leverage, or the action may be continuous. The tension on the spool is equal whether full or empty, by means of a screw and strap pulley. The binding arm which regulates the direction of the wire is jointed, and has an ingenious and effective swan-neck motion. The binding platform can be made to slide backwards or forwards to regulate the position of the band according to the state of the crop.

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163. David Kahnweiler, New York, N. Y., U. S.

COTTON-SEED HULLER FOR PLANTATIONS AND OIL MILLS.

Report.—Commended as being well made and thoroughly efficient, supplying an increasing want on cotton plantations, viz., by a means of preparing the cotton seed by the removal of shell and the cotton left by the gin, to be made into a highly valuable food. The mechanism is simple and the result satisfactory. Thus, the feed roller insures regular supply and prevents passage of nails, sticks, and other foreign matter that would injure the mill. The under roller has a smooth surface, carrying eight knife-sections so arranged as to follow each other like a screw; they are easily regulated to compensate for wear. The gin has four knives. The shell and seed fall into a fine reciprocating screen, being disturbed and distributed by a revolving spindle furnished with wooden teeth. The hulls are carried over the screen. The seed falls through the screen, and is received at a box screen, which, being properly agitated, separates the lighter portions of the hulls which have passed the wire screen, getting rid of them over the apron. Larger machines are made for manufacturers.

164. C. H. & L. J. McCormick, Chicago, Ill., U. S.

AUTOMATIC BINDER.

Report.—Commended as a highly-ingenious and meritorious attempt to attain a much-desired result, viz., a machine that shall cut and bind the sheaves automatically. As in the other inventions of this kind, an ordinary harvester-frame with revolving web and elevator is employed. The means of adjusting the reel, both up and down, forwards and backwards, to suit the condition of the crop, is simple and effective. The tying apparatus is regulated and governed by a traveling motion, which collects the grain into a convenient bundle, twists and cuts the wire successfully. The action is either automatic or controllable, and, though capable of further improvement, especially as regards the tension of the band, is sufficiently successful to merit recognition.

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165. Gaar, Scott, & Co., Richmond, Ind., U. S.

TEN-HORSE-POWER THRASHING MACHINE.

Report.—Commended as a well-made, efficient machine, specially for the arrangement by which straw is passed from the carrier by the action of a revolving picker, which insures the final separation of any grain remaining in contact with the straw; also for a lever belt-tightener; also for grain elevator with measuring spout and indicator, which registers the quantity thrashed; also for quality of work and capacity.

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166. G. Westinghouse & Co., Schenectady, N. Y., U. S.

THRASHING MACHINE FOR STEAM OR HORSE POWER, AND SMALL THRASHING MACHINE FOR HORSE POWER.

Report.—Commended for the action of cylinder concave and straw carriers in separating the grain from the straw; both cylinder and concave being open allow the passage of the larger proportion of the grain direct and at once to the shoe. What grain remains and passes the breaker falls through circular holes in the straw carriers, which are of wood. Also for the large space provided to receive the unthrashed heads from the end of the carrier.

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167. Nichols, Shepard, & Co., Battle Creek, Mich., U. S.

THRASHING MACHINE AND STRAW ELEVATOR.

Report.—Commended for specialty in the form of the carrier, which consists of a wooden screen suspended by rods and having open spaces, through which the grain drops on to a second carrier, taking it to the winnower at once. The passage of the straw and its proper agitation is effected by six rows of movable fingers. For the manner in which the grain and chaff is sifted on to the winnowing sieves, and thus distributed most favorably for the influence of the blast. The grain when winnowed can be delivered on either side of machine by a worm. Elevator attached to and forming part of machine, light, and folds up for traveling. Prices reasonable; of the largest class; doing excellent work.

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168. Minard Harder, Cobleskill, N. Y., U. S.

RAILWAY HORSE-POWER THRASHER AND CLEANER.

Report.—Commended for special features in the tread power to secure light running and minimum friction. For the manner in which the objection to an over-shot cylinder is overcome by a dust-blast in the cover, which effectually prevents the dust coming back into the face of the feeder. Also for the ingenious form of the straw shaker, which insures the proper agitation to separate the grain from the straw.

169. R. H. Allen & Co., New York, N. Y., U. S.

SUGAR LAND PLOWS, AND CANE CULTIVATOR.

Report.—Commended for strength and good material. The double mould plow for opening furrows for the planting sugar-cane is very proper for this use.

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170. Wm. L. Boyer & Brother, Philadelphia, Pa., U. S.

BROOM CORN MACHINES.

Report.—Commended for their utility and efficiency as broom manufacturing implements, consisting of lever vise for holding broom while it is being sewed, a broom winder or tyer, a broom corn sizer for regulating lengths for different-sized brooms, a cylinder with knives for removing seed, and the trimmer for shaping and finishing the broom. They are ingeniously arranged for labor-saving, and are strong and durable.

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171. Parke P. Flournoy, Bethesda, Md., U. S.

PRUNING IMPLEMENT.

Report.—Commended as an efficient pruner, to be attached to a long handle without any rope or wire attachment, the leverage being obtained by means of a slot in the knife-standard. The handle made in two parts adds to utility.

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172. William Earl, Nashua, N. H., U. S.

MACHINE FOR SHEARING SHEEP.

Report.—Commended as a very ingenious and efficient machine and great economizer of labor.

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173. American Shearer Manufacturing Co., Nashua, N. H., U. S.

SHEEP-SHEARING MACHINE.

Report.—Commended for the flexibility of the attachment of the shears frame to the connecting rod by spherical gearing, which enables the operator to use the machine in any direction; for using different-sized cutter plates according to the nature of the fleece. The cutting apparatus consists of two blades jointed together and worked by a crank, representing a lever of the first kind, which vibrates rapidly over the cutter plate; for the ease with which it is taken to pieces and the cutting edges sharpened. As many as ten sheep an hour can be fairly shorn by one man and a boy.

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174. John Ashcraft Hubbard, Marion County, Oregon, U. S.

FRUIT-TREE PRUNING SHEARS.

Report.—Commended for simple and efficient construction. The cutting blade of the shear is attached to the handle by a connecting iron rod that runs the whole length of the shaft. The handle itself works by means of a double lever that gives great power to the workman.

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175. George Plumb, North Bangor, N. Y., U. S.

GILT-EDGED MILK PAN AND COOLER.

Report.—Commended for its even cooling quality, thereby causing the production of more and richer cream. Easily cleaned, which reduces the labor of the dairy.

176. W. O. Campbell & Co., Richford, Vt., U. S.

COMPARTMENT MILK PANS.

Report.—Commended for good material, workmanship, and convenient form. Each pan is in two compartments, the lesser being one-third of the size of the whole, rendering the pans suitable for small or large quantities of milk. The pans, which are of sheet tin, are surrounded by a zinc or galvanized reservoir, which holds the water for cooling. The vent pipe is made with a joint at its bow, so that it can be raised or lowered according to the flow of water required.

177. H. H. Roe & Co., Madison, Ohio, U. S.

DAIRY APPLIANCES.

Report.—Commended for a large and varied assortment of dairy material, well made and adapted for factory use, comprising a small vertical engine and horizontal tubular boilers to provide steam for the cheese vats; large curd vats with water space around and under, through which circulate steam pipes, which discharge the steam into the water at various points, securing uniform heat; also for milk cans for carrying large quantities of milk.

178. Iron-Clad Can Co., New York, N. Y., U. S.

MILK CANS.

Report.—Commended for a large and varied assortment of cans for transporting milk; solid construction, with close-fitting covers. Also for weighing cans for factory purposes, of great capacity; and for cream cans.

179. Cortland Jewett Milk Pan Manufacturing Co., Cortland, N. Y., U. S.

MILK PANS.

Report.—Commended as well made and of convenient form; also for special arrangement for heating or cooling the milk by circulating tubes under bottom of pan.

180. The Universal Strainer Co., Rutland, Vt., U. S.

MILK STRAINER.

Report.—Commended for ingenuity, efficiency, and simplicity of construction, and moderate price.

The centre of the bottom of the strainer consists of a cone covered with fine wire gauze, which again is covered by a movable cap furnished also with gauze, so that the milk is strained twice. The gauzes are shielded in such a way that the weight of the milk cannot dissolve or drive the sediment through them. The strainer is easily cleaned.

181. Keystone Manufacturing Co., Sterling, Ill., U. S.

CIDER MILL AND PRESS.

Report.—Commended for good workmanship, finish, and solid construction, great strength, and ingenious combination, shown as follows:

The hopper is provided with an adjustable jaw to regulate the feed. The rollers, with a feed roller on the top, are conical, giving more surface for mashing the fruit, and are provided with ribs. One of the rollers runs three times quicker than the other, by which great efficiency is acquired. The bearings are adjustable by set-screws to regulate the wear.

In the press the follower is attached to the screw, and may be easily taken off.

182. Boomer & Boschert Press Co., Syracuse, N. Y., U. S.

POWER CIDER PRESS AND APPLE MILL.

Report.—Commended for large collection of power and hand machinery for cider making. The power press has a cross screw, with double leverage threads, so adjusted as to descend with a slow motion necessary for the thorough exudation of the juice. When the press has reached the proper point, it stops itself and rises five times as rapidly as it falls.

The apple mill comprises a greater cylinder, with a number of sections of knives adjustable by two screws. The feed is regulated by a spring jaw. The receptacle for the pulp has a movable door in the centre, so that the pulp can be fed at either end as most convenient for the press. Also for powerful hand presses.

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183. New York Plow Co., New York, N. Y., U. S.

CIDER MILL AND PRESS.

Report.—Commended for ingenious construction and efficiency of operation. The mill comprises a revolving cylinder with projecting ribs, with a reciprocating jaw or crusher furnished with teeth, which is worked from an eccentric on the main shaft. A balance wheel steadies the motion and reduces the labor of grinding, which is remarkably easy.

The press is worked by a strong screw, and the juice is extracted rapidly and efficiently.

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184. Thomas, Ludlow, & Rodgers, Springfield, Ohio, U. S.

CIDER MILL AND PRESS.

Report.—Commended for efficiency, good make, and reasonable price. This is very similar in construction to that of Mast & Co. Thus, we have a revolving roller in the hopper, with adjustable check. The mill proper is composed of two chilled rollers running at different velocities, the one with straight ribs, the other angular. The press is powerful, the follower being separate from the screw.

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185. P. P. Mast & Co., Springfield, Ohio, U. S.

CIDER MILL AND PRESS.

Report.—Commended for efficiency, good material and workmanship, and reasonable price. The hopper of the mill has a revolving barrel with four projections, or flanges, also an adjustable toothed back, which can be regulated by a set-screw. Below are the mill rollers, which revolve at different speeds. Merit claimed is that the fruit is crushed and not grated, whereby the juice is more effectually extracted. The screw of the press is powerful.

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186. W. C. O'Neil & Co., Philadelphia, Pa., U. S.

KEGS AND BARRELS.

Report.—Commended for ingenious formation of barrels out of veneers cut out in large pieces, the excellence of the machinery not shown being evidenced by the quality of the product. The necessary rotundity of the barrel is secured by sections cut out of the veneers.

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187. David Wimpfheimer, Philadelphia, Pa., U. S.

AUTOMATIC VINEGAR VAT.

Report.—Commended for its value as an automatic vinegar vat, consisting of several compartments with filtering tubes in each, also with air tubes to each compartment. Good vinegar is obtained in a few hours by filtering through non-conductors in different vats to the lower compartment when it is ready for use.

188. John M. Smith & Son, Philadelphia, Pa., U. S.

CEDAR VATS AND TANKS.

Report.—Commended for excellence of material and superior workmanship.

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189. W. H. Burkhardt & Co., Philadelphia, Pa., U. S.

CEDAR TANK AND OAK CASKS.

Report.—Commended for the very excellent materials used in their construction, and superior workmanship.

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190. Daniel Lombard, New York, N. Y., U. S.

HAND COFFEE HULLER AND STEAM RICE SCOURER.

Report.—The coffee huller is commended for excellence of design, which insures a highly satisfactory result, strength of material, and general utility. It comprises a cylinder with spring jackets, in which revolves a vertical fluted roller; the coffee carried round between the two is efficiently hulled.

The rice polisher is also recommended as a powerful, efficient mill, not liable to derangement, and capable of giving large results. It comprises a large iron pot, in which is a spindle furnished with a screw, and projecting arms revolving on the bottom. The pot is filled, and the rubbing goes on until the desired effect is produced. It is not intended to shell, but only to polish rice.

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191. D. Caldwell Millett, Holmesburg, Pa., U. S.

DEBORAH BEE-HIVE.

Report.—Commended as an economical hive, in sections, with movable combs, and facilities for inspection. It is easily made, is inexpensive, and well adapted from the protection it affords, for northern climates.

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192. R. R. Murphy, Fulton, Ill., U. S.

HONEY-EXTRACTING MACHINE.

Report.—Commended for being well made and efficient. The success of the operation, which is to remove the honey without injuring the comb, depends upon the care exercised to take the comb before the cells are capped. The apparatus comprises a copper cylinder tinned on the inside, with a vat for the honey at the bottom. Inside the cylinder is a rectangular revolving frame, having its longer sides covered with fine sieve-wire. The comb is placed in the box with the frames in which it was made, and the box is rapidly revolved by a handle and bevel gear. The centrifugal force causes the honey to discharge into the cylinder without the comb being injured, so that the latter is replaced in the hives and the bees at once commence the process of refilling.

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193. E. Penn Worrall, West Chester, Pa., U. S.

DOUBLE BEE-HIVE.

Report.—Commended for the facilities for observation, due to the inside being glass; for suitability both for winter and summer use. The space between the glass and the external frame allows of the insertion of quilt or cotton, and in summer the temperature is equalized. The iron frame renders its construction simple and durable. Every part is separate, can be readily taken to pieces, and no nails are used save in the cap; and for reasonable price.

194. John Matthews, Pleasant Grove, Pa., U. S.

BUTTER-PRINTING MACHINE.

Report.—Commended for ingenious construction and efficient action. The box is raised in order to remove the butter, and can be easily detached for cleaning purposes. The press is worked by a sun-and-planet gear.

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195. Thos. B. Parke, Philadelphia, Pa., U. S.

HAND CHURN.

Report.—Commended as a double-action rotary churn with a novel arrangement of dashers, viz., four revolving arms furnished with round rods; the arms are of different lengths, consequently the beaters travel in distinct circles; the shaft or axle carries a plate, which, revolving in the opposite direction to the sticks, throws the cream back against the sticks, thus securing a very complete action. The dashers are removed easily, and the churn can be scoured out thoroughly.

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196. J. Tingley, Philadelphia, Pa., U. S.

HAND POWER CHURN.

Report.—Commended for simplicity and efficiency, also for the manner in which the lid of the barrel is secured by a contracting band. When prepared for work, the churn is fixed upon a standard, being supported at the farther end by an iron stay from the standard; when this is removed, the churn being hinged to the standard can be turned upon end and easily cleaned.

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197. J. G. Koehler, Philadelphia, Pa., U. S.

BUTTER TUBS, CHURNS, AND ICE CANS.

Report.—Commended as a large collection of cedar wood butter tubs for conveying butter to market, with conveniently-arranged ice receptacles and shelves for packing the butter; also for cedar wood power churns, and cans for packing ice.

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198. Orange County Pail Co., New York, N. Y., U. S.

BUTTER PAILS.

Report.—Commended for a collection of well-made butter pails, of excellent material, with convenient fastenings. No nails are used, and they are easy to handle and clean.

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199. P. Embree & Son, West Chester, Pa., U. S.

REVOLVING BUTTER-WORKER (BY HAND).

Report.—Commended for simplicity, efficiency, and ingenuity of construction. The apparatus comprises a revolving table with a convex surface, made of cedar wood, on which the butter is placed. A revolving conical fluted roller with cleaner attachment, with a crank handle and a pinion working into a toothed gear in the centre of the table, causes the latter to revolve, and insures a thorough working of the butter, pressing out all liquids, which escape by an opening in the edge of the table. Also for great facility with which the roller can be detached and table cleaned.

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200. Speakman, Miles, & Co., West Chester, Pa., U. S.

BUTTER-PRINTING TABLE.

Report.—Commended for ease of adjustment, being a hinged box with movable mould, placed on table with spring and lever press; very simple, and easily cleaned; of great value in preparing butter for table use.

201. Evans & Baird, West Chester, Pa., U. S.

POWER CHURN.

Report.—Commended for simplicity of construction, which allows it easily to be cleaned, and for efficiency of operation.

The churn consists of a large, well-shaped barrel, which revolves on iron axles, with stationary beaters inside. The moving power is supplied by a one-horse gear, and is easily put in and out of gear by a simple lever.

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202. Philander Shaw, Scituate, Mass., U. S.

POWER BUTTER-WORKER.

Report.—Commended for simplicity of mechanism and efficiency of action. The apparatus consists of a vertical screw press, worked by a crank underneath, and a revolving circular table perforated with holes. This table forms the top of the buttermilk receptacle, which is also a receptacle for ice when required. The worker is made of perforated iron, tinned over, covered with a cloth, and having on the upper side a small box containing a sponge. Any buttermilk squeezed out upwards passes through the perforations and is absorbed by the sponge. So long as due care is observed in thoroughly scouring out the vessels, we think this a useful apparatus.

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203. John T. Ellsworth, Barre, Mass., U. S.

OSCILLATING CHURN.

Report.—Commended for simplicity of motion, which is secured by means of a revolving crank assisted by two heavy balance wheels. The merit claimed is that butter is rapidly produced by motion of the box without being brought in contact with the paddle or dasher, thus preserving the grain of the butter. The machine is strongly made, easily cleansed, and not liable to get out of order.

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204. Blymer Manufacturing Co., Cincinnati, Ohio, U. S.

FIXED HORIZONTAL ENGINE FOR SUGAR MACHINERY.

Report.—Commended for a strong, well-proportioned engine, with steam chest and cylinder properly lagged. The speed is regulated by cut-off from the governors instead of the ordinary throttle valve. This is done by means of a variable eccentric. The bed-plate is very solid. The water heater is of large capacity.

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205. Prof. Adolphe Corbett, Hicksville, Long Island, N. Y., U. S.

INCUBATOR AND ARTIFICIAL MOTHER.

Report.—Commended as simple, and, provided proper attention is paid to keeping up an even temperature, efficient. It comprises two distinct circular boxes, which are surrounded by fresh horse-manure. The degree of heat can be regulated by a ventilator at the top. The second box, where the chickens are reared, contains a circular cap, the under side covered with long wool, adjustable by means of a vertical rod with a screw head, to which it is attached. There is nothing to get out of order.

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206. S. A. Day & Co., Baltimore, Md., U. S.

AUTOMATIC INCUBATOR.

Report.—Commended for the highly ingenious mechanism by which the contraction or expansion of a bar of rubber and tin acts upon a pulley and weight which regulates the heat, increasing or diminishing the flame of a lamp which is the source of the heat. If

the lamp goes out, or gives out too much heat, the same mechanism acts upon a bell, arousing the attendant. For the simple and efficient manner by which the air is introduced and escapes at the top of the box, and for the arrangement of the egg boxes.

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207. E. & T. Fairbanks & Co., St. Johnsbury, Vt., U. S.

HAY, CATTLE, AND CHEESE-FACTORY SCALES.

Report.—Commended for a cheese-factory scale. Owing to the presence of five beams, four separate weighings can be registered on the beam without having to make the deduction for the weight of the can. The first beam shows this, and the others give four distinct weighings of the product. For a useful platform scale for hogs, for butcher's scale for oxen and sheep, for trussed lever scale for hay and cattle, and for general excellence of collection.

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208. The Brandon Manufacturing Co., Brandon, Vt., U. S.

FARMERS' WEIGHING MACHINES.

Report.—Commended for the improvements in the Howe scale, principally the protection to the bearings; for strength and simplicity of construction; for the comparative ease with which a large wagon scale can be fixed; and for general collection of scales for various purposes.

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209. Myhan, Schenck, & Co., New York, N. Y., U. S.

SMOKED-BEEF CUTTER.

Report.—Commended for ingenious and simple mechanism, securing a fine, accurate, and adjustable cut. This is accomplished by a broad knife driven by a crank and driving wheel, making what is known as a draw cut. A crank-rod from opposite side of wheel works a ratchet and pawl, which actuates a worm working in a rack on under side of table, and so runs a regular self-feed.

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210. H. P. Rankin, Allegheny, Pa., U. S.

MEAT CHOPPER.

Report.—Commended for simple, solid, and ingenious construction. The meat is placed in a slowly-revolving tub, and chopped by means of three sets of double cast-steel knives so arranged under different angles as to secure equal action in every portion of the tub. The crank-shaft works in a slotted standard, which allows the knives to rise, avoiding breakage, in case of obstructions, as bones, stones, etc., etc.

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211. Peter Lynch, Mount Holly, N. J., U. S.

HOG-SCALDING TUB.

Report.—Commended for strength, good material, large capacity, and facilities for maintaining the temperature of the water, due to the bottom of the tub being occupied with a copper tubular furnace returning to a stove-pipe. Above the furnace is a removable slatted platform, which is readily removed when accumulations of hair, etc., render it necessary. With four men to attend to the pigs, the work goes on rapidly.

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212. Nathan Stockwell, Bainbridge, N. Y., U. S.

FEEDING TROUGH.

Report.—Commended for its value and convenience as an economical feed trough. A swinging wall with compartments answers the double purpose of protecting the weaker animals from the strong while eating, while by means of cams with a lever the wall can be swung to inside of the trough, thus keeping it clean when not in actual use.

213. James L. Jackson, New York, N. Y., U. S.

STABLE FITTINGS.

Report.—Commended for a large collection of galvanized iron stable fittings, of all kinds, well made, convenient, and safe; all edges are rounded; also for good drainage arrangements.

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214. C. B. Rogers, Philadelphia, Pa., U. S.

FRUIT BOXES AND BASKETS.

Report.—Commended for great variety of articles, adaptability for designed use, ingenuity of make, and very reasonable cost.

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215. S. D. Foot, New York, N. Y., U. S.

FRUIT-COOKING APPARATUS (BY STEAM).

Report.—Commended for the employment of steam instead of boiling water, which secures quicker and more perfect action. The apparatus comprises a gas stove or other generator, a tin boiler with a steam-chest attached, from which small tubes convey the steam into the fruit-jars. All descriptions of fruit can be cooked in from ten to fifteen minutes.

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216. Oscar F. Tiffany, San Francisco, Cal., U. S.

FRUIT AND VEGETABLE DRYING MACHINE.

Report.—Commended for economical method of heating the apparatus by the introduction and mixing of cold air with that which comes direct from the furnace, a natural draft being secured by the draft stack; for the V-shaped roof or ceiling to the drying chambers, combined with gutters beneath them, which collect and remove any moisture that may condense, thus securing a dry air. Sieves holding the articles to be dried run on wheels, and can be easily taken out, or, if required, elevated from one floor to another. It should be mentioned that the gutters for removing the moisture terminate in siphon spouts, so that no heat can escape thereby.

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217. George A. Deitz, Chico, Cal., U. S.

FRUIT-DRIER.

Report.—Commended for a simple, well-arranged machine, which secures a good circulation of hot air, acting upon an extensive surface. The arrangement for regulating the temperature is very efficacious. The fruit is placed upon trays in frames, which are run upon castors, and easily removed. Temperature can be varied from 70° to 200°.

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218. Frank A. Parker, Reading, Pa., U. S.

APPLE-PARING MACHINE.

Report.—Commended as well made, of ingenious construction, and thoroughly efficient, paring the whole of the peel, taking out the core, and throwing the apple off the fork. Reasonable in price.

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219. George Bergner & Co., Washington, Mo., U. S.

APPLE AND PEACH PARER, CORER, AND SLICER.

Report.—Commended for ingenious combination of a parer, corer, and cutter. The operator, after having pared the fruit, winds back the fork, which relieves a catch; the shaft is then forced forward to the corer and cutter. The operations are rapidly and efficiently performed. The angle of the knife adjustable, in order to regulate the thickness of peel. Well made and reasonable.

220. Jones Brothers, Sturgis, Mich., U. S.

FRUIT DRIER.

Report.—Commended as a machine capable of rapidly and efficiently drying large quantities of fruit, owing to the operation of a double-action fan-driver by horse or steam power. The heat is regulated by adjustable valves. Large screen surface in ten sections, each carried on rollers, facilitates the process of filling and emptying the fruit. The escape of moisture is provided for by hygrometric openings.

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221. R. H. Allen & Co., New York, N. Y., U. S.

ROW CORN DRILL AND HORTICULTURAL IMPLEMENTS.

Report.—Commended for being tight, well made, with favorable features of adaptability. Thus, by changing the wooden corn-seed roller it can be made available for sowing small seeds as well as Indian corn. At the base of the seed-hopper is a horizontal feed-roller, with a number of screws at intervals; by sinking these screws, one or each of the openings become corn receptacles: a brush on each side prevents more than the desired quantity of seed being carried round. For small seeds, a false bottom, with varying-sized holes according to the nature of the seed to be sown, is introduced, and the wooden roller is replaced by a revolving brush. The driving wheel is furnished with a series of cog gearing; by altering the position of the pinion, which slides on the spindle, and can be actuated from above by the handles, the quantity of seed is regulated.

The horticultural implements as a collection comprise in simple combination a seed sower, a cultivator, a rake, a scuffle hoe, a shovel plow, etc., all easily changed and adjusted to the one frame and wheel.

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222. C. Russell & Co., Canton, Ohio, U. S.

COMBINED REAPING AND MOWING MACHINE (THE PEERLESS).

Report.—Commended for a strong, well-made, and carefully considered machine, capable of doing excellent work, especially as a mower. Also for the following points of merit. The driver's seat slides on parallel springs, and thus the pole balance can be accurately secured. For the mode of attaching the connecting rod to the crank by universal joint, so that if the angle of the frame is altered, or the knife-bar is put up or down, there is no friction caused by the alteration. The gearing is simple, strong, and well boxed off. The pitman box cast in two parts, with a piece of leather between, which accommodates it to the wear of the shaft. The fingers are of malleable iron, steel-plated, with hollow spaces under for the accumulation of gum.

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223. Clement & Dunbar, Philadelphia, Pa., U. S.

CEDAR WARE CHURNS AND ICE-CREAM FREEZERS.

Report.—Commended for beauty, variety, and excellent workmanship and material, as shown by the collection of samples presented. The churns (Spain's patent improved) and the ice-cream freezers (Gooch patent) are well made, and of approved models for the general market.

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224. White Mountain Freezer Co., Laconia, N. H., U. S.

FREEZING MACHINES FOR ICE-CREAM.

Report.—Commended for very complete action obtained by triple motion. The two sets of dashers work in opposite direction, and the cream can also revolves. The dashers are readily removed, the gearing simple. Price moderate, and the machine decidedly useful.

225. Murphy & Broom, Philadelphia, Pa., U. S.

BIRD CAGES AND WIRE WORK.

Report.—Commended for a large collection of wire cages and galvanized flower stands, summer-house, and rustic wood work.

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226. Hendryx & Bartholomew, Ansonia, Conn., U. S.

BIRD CAGES.

Report.—Commended for a large and varied collection of bird cages, of ingenious construction.

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227. Osborn Manufacturing Co., New York, N. Y., U. S.

BIRD CAGES.

Report.—Commended for a magnificent aviary, and a considerable collection of ingeniously constructed cages of various designs.

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228. Blymer Manufacturing Co., Cincinnati, Ohio, U. S.

SUGAR MACHINERY.

Report.—Commended for the large collection of excellently constructed machinery for expressing and evaporating the sugar; also for horizontal engine and intermediate gearing to work the mill. Two forms of evaporators are shown. The smaller one, portable, on rockers, can be adjusted to regulate the flow of syrup.

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229. R. H. Allen & Co., New York, N. Y., U. S.

PHILLIP'S SPIRAL CORN HUSKER.

Report.—Commended for strength, durability, and utility as a corn husker and separator. The operations are effected, first, by two revolving transverse rollers, the upper one being fluted. These detach the stalks, which are carried away by an elevator; the detached corn falls into longitudinal rollers with indented spaces, having a number of projecting pins; these detach the husk, which passes through openings, while the corn traverses the rollers and falls out at their end. From twenty-five to fifty bushels an hour can be operated, according to the nature of the crop and power employed.

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230. George Neighbour & Sons, London, England.

BEE-HIVES.

Report.—Commended for a large and varied collection of economical bee-hives, so ar ranged that the honey can be taken without the destruction of the bees. Special attention is directed to the unicomb hive, with venetian blinds, to allow the bees to be exposed to light whilst the sun's rays are excluded; also to a honey extractor by centrifugal force, which removes the honey from the comb without injuring the latter, which can be returned to the hive.

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231. William Wilkinson & Sons, Sheffield, England.

SHEEP AND HEDGE SHEARS.

Report.—Commended for thorough good material, and as well made and finished.

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232. J. P. Fison, Feversham Works, Cambridge, England.

SAFETY GUARD FOR DRUM CYLINDER AND SMALL VERTICAL ENGINE.

Report.—Commended for securing safety to the feeder of a thrashing machine without in any way interfering with the work. In some measure it assists the passage of the mate-

rial to be thrashed into the cylinder. The invention comprises a revolving cylinder of wood placed above and somewhat in front of the cylinder, leaving ample space for the material to be fed in between it and the feed-board. It is driven by a strap from the crank of the shaker below. Its shaft rests in a slotted bearing of the cover. In the event of any weight, such as the man's body, falling upon or against the drum guard, it is depressed, the strap is loosened, motion ceases, and the cylinder is effectually covered. The construction is simple, very little power is absorbed in working, and the cost is small. Also we recommend for favorable consideration a small vertical two-horse-power portable engine of economical construction, and suitable for light work, such as chaff cutting, grinding, root cutting, etc.

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233. James Fussell, Sons, & Co., Frome, Somerset, England.

SCYTHE BLADES, REAP AND OTHER HOOKS, AND HAY KNIVES.

Report.—Commended for a large exhibit of superior scythe blades, grass hooks, and hay knives, from thorough good material, uniformly made, and exhibited in a convenient form.

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234. Arthur Winkler Wills, Park Mills, Birmingham, England.

TOOLS, HOES, AND AXES.

Report.—Commended for excellence of material, good and honest workmanship, and varying utility.

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235. Aveling & Porter, Rochester, Kent, England.

STEAM TRACTION ROAD ROLLER.

Report.—Commended for strength, durability, efficiency, and reasonable cost. The engine loaded for work weighs ten tons, which is distributed over a wheel surface of six feet. The front rollers, which also form the steering wheels, are forty inches (divided into two sections). The hind wheels are each sixteen inches wide, and these carry the larger portion of the weight. Were it equally divided, the average pressure would be three hundred and eleven pounds per linear inch. The principle of dividing the rolling surfaces as much as possible is of great importance in road making; since the great weight thus distributed penetrates, so as to speak, beneath the surface, finds out the weak spots, and causes an even uniform condition underneath, while the inequalities of the surface can be overcome by the addition of metal in the holes. It should be particularly noted that the formation of the wheels, larger on the inner than the outer-side, tends to produce a road with a slight inclination from the centre, which is considered an important feature. The naves of the wheels are two and one-half inch cast metal. The engine is speeded to travel two miles an hour. In repairing, an old road-spike can be attached to the hind wheels, which, by tearing up the surface, greatly assist the constructor in preparing a binding surface for the new material.

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236. Massey Manufacturing Co., Newcastle, Ontario, Canada.

SHARPE'S PATENT DUMPING HORSE RAKE.

Report.—Commended as a reliable, well-made horse rake, with simple and efficient dumping appliance, effected by break bands on the axles of both driving wheels tightened by foot leverage through connecting rods. The rakes or tines are coiled round the wooden axle, which is four inches in diameter. This secures a firm attachment, but is not the most convenient arrangement for removing the teeth.

237. Rowland Dennis, London, Ontario, Canada.

POTATO DIGGER AND RIDGING PLOW COMBINED.

Report.—Commended for a combined machine adapted by an easy change to perform three several functions. As a potato digger the plow point and share upturns the potatoes, which are separated from the earth by a series of fingers or prongs projecting back on each side. Attached to the share, this point and share are removable. Another and smaller point is readily attached, behind which are two mould-boards, which can be expanded so as to turn out a furrow if used for making a drill in which to plant potatoes, or as a ridging plow to throw the earth on either side if used for the purpose of earthing up the growing plants.

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238. L. D. Sawyer & Co., Hamilton, Ontario, Canada.

MOWING AND REAPING MACHINES.

Report.—Commended for excellent material and ingenious arrangement. Clutch gear replaced by eccentric ratchet on driving wheels without springs. Inside driving wheel one inch greater diameter than outside wheel, consequently covers more ground at each revolution, and tends to counteract side draft. Knife-bar suspended on drag-bar, which can be screwed up to frame, so as to secure the position of the bar always at a right angle. As a reaper the platform can be hinged back behind the main frame, so as to facilitate its passage through narrow gateways.

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239. Joseph E. Stong, Ontario, Canada.

SWINGING FARM GATE.

Report.—Commended for an ordinary gate, not too heavy, sustained between two vertical standards at its rear end, and by two inclined levers, which proceed from the bottom of the rear end to the top rail of the gate, near the middle, and are there confined by sound bolts, which allow them to swing vertically and radially as the gate rises. The gate is raised by an attachment to the short end of a long lever, with its fulcrum on one of the upright standards, the long arm of which stands out at right angles to the rear of the gate far enough to be reached by one on horseback or in a carriage. The gate being so raised is carried up and over the segment of a circle the length of the gate, and set out and down its own length. A pull on the same lever, or on a similar one on the other side of the gate, throws it again over and back to place, and restores it to a closed position, where it is automatically locked.

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240. Acton Plowing Co., Ontario, Canada.

GENERAL PURPOSE PLOW.

Report.—Commended as a strong, serviceable implement, with adjustable coulter box, which slides on beam; for solid wrought-iron socket, giving great strength. The sole is cast, and can be easily removed; mould-board and land side steel.

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241. Thomas Yeandle, Stratford, Ontario, Canada.

SINGLE PLOW.

Report.—Commended for useful general purpose plow, well made, saving of undue friction by peculiar construction of under side of share and mould-board; for steel sole with small ground surface; for peculiar form of land side, allowing of considerable wear; adjustable steel mould-board of good form.

242. C. Duperrow, Stratford, Ontario, Canada.

IRON DIAGONAL HARROW.

Report.—Commended for construction of teeth, which, being diagonal, can be changed; also for the form of collar, which is diagonal, and fits into similar openings on the lower bars of the frame, thus securing a tight joint and making the connection independent of the screw and nut.

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243. Munroe & Agar, Seaforth, Ontario, Canada.

COMBINED IRON AND WOOD PLOW.

Report.—Commended for the mode of attaching the wooden handles, which are riveted into strong wrought-iron standards well stayed, and for general excellence of construction.

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244. G. Wilkinson, Aurora, Ontario, Canada.

DOUBLE PLOW.

Report.—Commended as a well-made implement, likely to be useful in light lands; for the method of adjusting the width of furrows, and for the use of a friction-wheel behind the mould-board in place of the ordinary sole and land side; for reversible standard for this hind wheel.

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245. Peter Grant, Clinton, Ontario, Canada.

EXCELSIOR HAY FORK AND CONVEYER.

Report.—Commended as a simple, cheap, and efficient labor saver. The conveyer is particularly commendable. The friction rollers travel on an ordinary scantling three by four, which is supported at intervals by simple hooks. The fork is composed of three tines, the centre of which has a double harpoon. The barbs rest on shoulder of standard, which gives great strength. The conveyer frame has friction rollers above and under the rail.

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246. John Watson, Ayr, Ontario, Canada.

GENERAL COLLECTION OF AGRICULTURAL IMPLEMENTS.

Report.—Commended for the large and useful collection of machinery, and for general good workmanship, especially directing attention to a two-rowed ridge drill for root crops, and a heavy wooden roller adjustable to hillsides and inequalities of surface; also for metal mills, pulping and slicing machines, and for a pneumatic chaff cutter.

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247. Thomas Wilson, Richmond Hill, Ontario, Canada.

FANNING MILL.

Report.—This mill is constructed on the most approved models, and in a thorough manner. It has an unusually large number of screens so arranged as to assort every kind of grain and seed, and chutes to carry off the tailings. The shaker is made in two parts, which move in unequal motions, thus causing a more thorough separation of the contents. The machine was arranged to be run by manual or other power.

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248. David Maxwell, Paris, Ontario, Canada.

POWER CHAFF CUTTER.

Report.—Commended for power chaff cutter, with patent gearing by which reverse motion, change of cut, and stop motion are obtained without the use of a clutch or change

of wheels. This is effected by an ingenious cluster of wheels on lever axle; when the lever is in the stop hole, pulling the handle towards the feeder and from the machine reverses the rollers, a fairly safe arrangement.

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249. A. Anderson, London, Ontario, Canada.

HAND BOX CHAFF CUTTERS.

Report.—Commended for a diagonal blade with a ragged-edge knife, which is also adapted for a hay cutter and bread knife.

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250. Haggert Brothers, Brampton, Ontario, Canada.

THRASHING MACHINE AND HORSE GEAR.

Report.—Commended for efficiency, strength of construction, and good workmanship; for the protection against accidents by the shielding of all shaftings; for the strong attachment of the poles to the horse gear; the drum is driven by gearing, and all the other speeds are multiplied from a comparatively slow motion, which is more economical than the ordinary plan of reducing speed from the drum shaft; for simple arrangement by which straw can be delivered by elevator at any required angle.

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251. John Abell, Woodbridge, Ontario, Canada.

PORTABLE ENGINE AND THRASHING MACHINE.

Report.—Commended for economical arrangement of water heater and general excellence of engine, especially good lagging, and complete boiler fittings; for simplicity, strength, and efficiency of the thrashing machine; for adjustable straw elevator, and general compactness of parts.

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252. Jacob Bricker, Waterloo, Canada.

LITTLE CHAMPION THRASHING MACHINE.

Report.—Commended as a well-made machine, either driven by gearing or strap, the gearing well protected by a cover; for using Guiser's self-regulating air openings for fan, which tend to insure regularity of blast; for efficient straw-shakers worked by double reacting crank, insuring due progression and agitation of the straw, and complete separation of loose grain, which falls through openings in the shakers. The winnowing shoe, actuated by cams on either end of a revolving cross screen, gives a steady, uniform motion; straw carrier, hooked on to end of machine when working in a straight line, can be detached and set upon trestles, if required, to deliver at an angle; carriage on two wheels with blocks at either end: price reasonable.

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253. Peter Borissovski, Moscow, Russia.

BEE-HIVE.

Report.—Commended for ingenious design and good construction.

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254. Nicholas Westberg, Kharkof, Russia.

THRASHING MACHINE.

Report.—Commended for excellence of manufacture and material. The machine comprises only the cylinder, with smooth beaters and an adjustable concave, the former driven from both sides by friction rollers.

255. Lilpop, Rau, & Loevenstein, Warsaw, Russia.

PORTABLE ENGINE.

Report.—Commended as a very strong machine, suitable for rough roads and for a country where repairs are difficult to execute. The frame is carried on four wheels; the front ones lock right under the frame. The boiler, which is vertical, contains forty-two large and ten small tubes, which are so arranged as to insure great heating surface and quick action. This engine on trial got up steam in little over half the time that some others required. The engine has some defects. In the first place, its position in reference to the fire-box is unhandy, being on the opposite side and at some distance. The pump is defective, having no spring valve; on several occasions it failed to act. The water heater is large and efficient. No governors. The result of the trial was satisfactory.

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256. Florian Grubinsky, Warsaw, Russia.

REAPER.

Report.—Commended for simplicity and solidity of construction. The whole propelling machinery is capped in the driving wheel, preventing contact with the dirt. A wormed groove gives to the roller of the gimbal joint the necessary and ample motion of the knife, and is not liable to get out of order.

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257. Eugene Mercier, Epernay, France.

MACHINERY USED IN THE MANUFACTURING OF SPARKLING WINES.

Report.—Commended for various highly ingenious, efficient, and labor-saving machines used in the production of champagne, viz., the bottling apparatus for bottling from the cask without loss of gas; by these machines as many as eighteen thousand bottles a day can be filled, for corking, and applying strong iron clips which secure them, whilst the bottles are racked in an inverted position requisite for the deposit of sediment, and instantly removed without agitation, thus allowing the escape of the lees and the proper clarifying of the wine; for the machine by which the regulated proportion of syrup is added according to the market; and for the facility with which the bottling, tying, and wiring is effected.

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258. Mabille Brothers, Amboise, France.

WINE AND OIL PRESSES, AND RAISIN BREAKER.

Report.—Commended for strength of construction, excellence of manufacture, and utility; especially for the application of a powerful multiple lever to the press screw, which is admirable on account of simplicity, power, quick action, and good material.

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259. Joseph Pernollet, Paris, France.

GRAIN AND WEED SEPARATORS.

Report.—Commended for excellent construction and thorough efficiency of the weed and grain separators, and specially for the perfect separation of the cockle seed, which is so prevalent in France. The cockle machine comprises a revolving cylinder set on an incline. The first portion of the cover has long narrow openings, through which small seeds and broken grains and very inferior grain pass. The remainder of the internal surface is occupied with the cockle cups or indentations, into which the seed finds its way, and passing a scraper, which removes any projecting grain, such as wheat, which might otherwise be carried round, the cockles fall into a screw channel and are delivered at the mouth above and distinct from the good grain. The power is conveyed from a fly-wheel turned by hand through gearing wheels. The motion is steady, smooth, and the result thoroughly

effective. In the grain separator the cylinder is covered with netting of different-sized mesh and differently-formed holes, and the section can be readily replaced. Four or five samples can be made. These are most valuable machines.

260. José Antonio Masquera, Caracas, Venezuela.

COFFEE PULPER.

Report.—Commended for simplicity and solidity of construction and efficiency of work. This newly-patented coffee pulper is easily worked by one man at the crank, and instead of having buttoned cylinder has a tooth-fluted one, which prevents the breaking of the berries.

261. Felipe Perez, Havana, Cuba.

HORSE SUGAR-CANE CULTIVATOR.

Report.—Commended for its utility as a sugar plantation implement. It consists of a wooden frame with teeth, and with knives of iron laid with steel. The driver operates it with two handles. The depth is regulated by small wheel in front. Also for strength and durability.

262. José Antonio Antunes, Rio de Janeiro, Brazil.

APPARATUS FOR MAKING COFFEE.

Report.—Commended for its excellence as an economical coffee-kettle. It consists of an upper and lower division. The upper contains filter and tube through centre of bottom, which is inserted through top of lower division into the water. The ground coffee is placed in filter, the water is heated (by means of spirit-lamp in basement of lower division) and forced through tube and filter, the lamp is extinguished, the liquid recedes to lower part without evaporation or loss of aroma, and an excellent clear coffee is ready for use.

263. Mayer & Co., Kalk-on-the-Rhine, Germany.

WINNOWING AND SORTING MACHINE.

Report.—Commended for the combination of a winnowing and weed-separating machine, by means of a circular revolving screen and reciprocating screen placed below the feed hopper. The grain is assisted in its passage from the hopper to the screen by a force-feed spindle furnished with beaters. The internal surface of the cylinder is stamped with indentations of two sizes, separated by a screen in the centre. In these indentations the seeds of the cockle are collected, and, as they fall from the screen, are collected in a trough and forced along to the end of the cylinder by an endless screw. The largest grains are separated by the reciprocating screen; then all small grains and seeds pass through longitudinal openings in the first portion of the revolving screen. Cockles, etc., are removed as described, and the remainder of the grain is carried down to the mouth and delivered below the cockle spout. The motions are communicated by straps, which is certainly not the best arrangement.

264. Royal Wurtemberg Smelting Works, Friedrichsthal, Germany.

SCYTHES.

Report.—Commended for good commercial collection, good workmanship, and excellent material.

265. Austrian Commission for the International Exnibition at Philadelphia, Vienna, Austria.

SCYTHE BLADES.

Report.—Commended for a large and varied collection of scythe blades, the product of different manufactures; of excellent material.

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266. Carl Atterling, Orebro, Sweden.

CHEESE-MAKING APPARATUS.

Report.—Commended as an efficient apparatus for making cheese on the Cheddar system; comprising a steam generator of economical construction, circular cheese vat of large dimensions of copper, tinned over, with steam jacket around and under, provided with water-supply tube and safety valve.

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267. M. Rehnström, Tibble, Köping, Sweden.

PLANS OF CHEESE AND DAIRY FACTORIES.

Report.—Commended for designs for cheese and butter factories, well executed, economically and conveniently arranged.

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268. Kalinge Manufactory, Ronneby, Sweden.

DAIRY APPLIANCES AND KITCHEN UTENSILS.

Report.—Commended for a large collection of dairy appliances and kitchen utensils of excellent material and workmanship.

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269. S. H. Samuelson, Töskefors, Sweden.

MACHINES FOR MANUFACTURE OF TUBE PEAT.

Report.—Commended for the improved form in which the fuel is made. The tubular form insures more rapid and complete drying, so that, without artificial heat, the percentage of water can be reduced to from ten to twelve per cent. The combustion of the peat is also greatly facilitated. Even thickness of the tubes is secured by the use of pistons. The machines exhibited are for foot leverage and power. In the former, a long table receives the peat, pistons at each end are worked by foot leverage, the tubes as made falling out below. In the power machine, the peat is propelled towards and into the mould by a screw working in a trough.

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270. C. E. Petterson, Långö, Elfdalen, Sweden.

COLLECTION OF SCYTHE BLADES.

Report.—Commended for ouality of material, suitability of form, and excellence of manufacture.

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271. L. P. Eklundh, Hjelmafors, Ulricehamn, Sweden.

COLLECTION OF IRON PLOWS.

Report.—Commended for excellence of material, reasonable price, and good form. The plows made for the Russian market, where the soil is dry, have a vertical friction-wheel immediately behind the land side and projecting three-fourths of an inch below the sole; also a small wheel below and behind the mould-board converts sliding into rolling friction, and reduces the draft. Such arrangements are unsuitable for Swedish agriculture, as the soil is strong and moist. The body of these plows is cast in one piece with the land side,

and the side of the sole projects somewhat beyond the land side, reducing wear of the latter; beams either solid or split. The land side is prolonged, and occupies a space between the mould-board and share.

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272. Göteborg Machine Manufacturing Co. (Limited), Göteborg, Sweden.

COLLECTION OF IRON PLOWS.

Report.—Commended for excellence of material, form, workmanship, and low price. Most of these plows have split beams, with strong frame and well-braced handles bolted on to beam and frame, and fixed coulter socket with adjusting set-screws.

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273. Walter A. Wood, Hoosick Falls, N. Y., U. S.

SWEEP RAKE REAPER.

Report.—Commended for good material and workmanship, and for efficiency as a sweep rake reaper with automatic and controllable delivery, admitting of considerable alteration to suit the varying conditions of crops. Gavels left in fair form for binding and very favorable for curing, the butts laid well up to sun and wind. The rake arms strongly attached to standard. The pole can be raised or depressed. The frame is made in three pieces, well secured with rivets.

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274. Walter A. Wood, Hoosick Falls, N. Y., U. S.

HARVESTER (HEADER).

Report.—Commended for its utility as a rapid and economical harvester; it is particularly adapted to the dry harvest seasons of the Pacific coast; it is ingeniously arranged for elevating the headed grain into wagon boxes made for the purpose, that convey it to the thrashing machine. The draper or elevator runs parallel with the sickle, and is driven by belt running pulley on upper end of elevator. The height of cut is regulated by lever easily operated by driver while running. The sickle and reel are raised together or separate, as required. The requisite number of horses are hitched to the pole behind the machine, thus driving it before them, entirely obviating side draft. For its cheapness and durability.

SIGNING JUDGES OF GROUP XXIII.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

JOHN COLEMAN, 1, 2, 4, 9, 12, 15, 16, 17, 19, 20, 21, 22, 23, 26, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 43, 46, 48, 49, 50, 51, 52, 53, 54, 58, 59, 62, 68, 71, 72, 73, 75, 76, 77, 78, 79, 82, 83, 85, 86, 88, 90, 91, 93, 94, 100, 101, 103, 104, 105, 106, 107, 109, 111, 112, 113, 116, 119, 121, 124, 125, 127, 128, 129, 131, 137, 139, 140, 142, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 159, 160, 162, 164, 165, 166, 167, 168, 171, 173, 176, 177, 178, 179, 182, 183, 184, 185, 186, 191, 192, 193, 194, 195, 196, 198, 202, 205, 206, 207, 208, 209, 211, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 224, 225, 226, 227, 228, 229, 230, 232, 235, 236, 238, 240, 241, 242, 243, 244, 245, 246, 248, 249, 250, 251, 252, 253, 254, 257, 258, 259, 263, 265, 266, 267, 269, 270, 271, 272, 273, 274.

JAMES BRUCE, 3, 8, 10, 13, 44, 45, 56, 63, 66, 69, 74, 89, 97, 110, 144, 145, 170, 187, 188, 189, 200, 203, 212, 234, 261, 262, 264.

JAMES S. GRINNELL, 5, 6, 11, 81, 92, 99, 115, 120, 237, 239, 247.

JOHN BRADFORD, 7, 42, 57, 61, 65, 114, 132, 133, 134, 163, 190.

E. OLDENDORFF, 14, 18, 25, 27, 55, 70, 80, 123, 143, 172, 174, 180, 181, 197, 199, 201, 210, 231, 233, 256, 260, 268.

JOHN P. REYNOLDS, 24, 47, 60, 64, 67, 84, 87, 95, 96, 98, 117, 122, 126, 158, 223.

PEDRO PAES LEME, 102, 161, 175.

FERMIN ROSILLO, 108, 118, 169.

GEO. E. WARING, JR., 130, 135, 136, 138, 141, 204, 255.

SUPPLEMENT TO GROUP XXIII.

REPORTS
OF
JUDGES ON APPEALS.

JUDGES.

JOHN FRITZ, Bethlehem, Pa.
EDWARD CONLEY, Cincinnati, Ohio.
CHARLES STAPLES, JR., Portland, Me.
BENJ. F. BRITTON, New York City.
H. H. SMITH, Philadelphia, Pa.
COLEMAN SELLERS, Philadelphia, Pa.
JAMES L. CLAGHORN, Philadelphia, Pa.
HENRY K. OLIVER, Salem, Mass.
M. WILKINS, Harrisburg, Oregon.
S. F. BAIRD, Washington, D. C.

1. H. N. Prout, Westfield, Mass., U. S.

HORSE HOEING MACHINE.

Report.—It is a well-made, serviceable implement, well adapted to the purpose intended.

2. E. D. & O. B. Reynolds, Brockton, Mass., U. S.

GANG PLOW WITH SULKY AND CULTIVATOR ATTACHMENTS.

Report.—Commended for good construction, simplicity, and utility.

3. William Farr Goodwin, Stelton, N. J., U. S.

MOWING MACHINE (RECIPROCATING SCREW).

Report.—Commended for its simplicity and cheapness of construction, lightness of draft, having found it meritorious on a severe trial.

4. Frank W. Chapman, Morrison, Ill., U. S.

HONEY EXTRACTOR.

Report.—Commended for ingenuity and value of improvement, with special fitness for the purpose intended.

5. Hiram Holt, East Wilton, Me., U. S.

HAY KNIVES.

Report.—Superior articles; very meritorious; efficient tools, and cheap in price.

6. D. M. Osborne & Co., Auburn, N. Y., U. S.

COMBINED REAPER AND MOWER (WHEELER NO. 6).

Report.—Commended for simplicity of parts, originality of design, excellence of workmanship, light draft, and durability.

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7. Homer J. Blakeslee, Corry, Pa., U. S.

IMPROVED SELF-ACTING SWINGS.

Report.—Commended for novelty, ingenuity, and fitness for purpose intended.

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8. Higganum Manufacturing Co., Higganum, Conn., U. S.

AGRICULTURAL IMPLEMENTS.

Report.—Good exhibit, and well suited for the purposes intended.

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9. H. H. Wills, Alton, Ga., U. S.

GRANGE MILL.

Report.—Commended for novelty, durability, excellence of work upon all varieties of cereals, and general utility.

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10. Bucher, Gibbs, & Co., Canton, Ohio, U. S.

COMBINATION PLOW.

Report.—It is of great strength, excellent finish, and good shape.

---

11. Lewis B. Covert, Jersey City, N. J., U. S.

ADJUSTABLE LADDER.

Report.—It is well made, and of easy adjustment.

---

12. B. C. Taylor, Dayton, Ohio, U. S.

HAY RAKE.

Report.—Good in make, and seems to have all the advantages of other hay rakes.

---

13. Walter A. Wood, Hoosick Falls, N. Y., U. S.

MOWING MACHINE.

Report.—It is of excellent workmanship; among the most valuable and well adapted to the purpose intended.

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14. A. P. Dickey, Racine, Wis., U. S.

DICKEY'S FARM AND WAREHOUSE FANNING MILLS.

Report.—Commended for good workmanship, and great rapidity of work.

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15. Barrows, Savery, & Co., Philadelphia, Pa., U. S.

PRINDLE'S STEAMER.

Report.—Good machine, and well adapted to the purposes intended.

16. **A. J. Sweeney & Son, Wheeling, W. Va., U. S.**

MOWER AND REAPER.

Report.—Commended for simplicity of construction, durability, ease in management, and cheapness.

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17. **Porter Blanchard's Sons, Concord, N. H., U. S.**

BLANCHARD CHURN.

Report.—It is a good churn, and well fitted for the purpose intended.

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18. **Barnard, Bishop, & Barnards, Norwich, England.**

GARDEN FURNITURE (IN IRON).

Report.—Commended for variety, convenience, good work, and fitness for the purpose intended.

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19. **A. Douglass Hilton, Grahamstown, Cape of Good Hope.**

OSTRICH INCUBATING MACHINE.

Report.—Commended as an apparatus for hatching out ostrich eggs in a simple and efficient manner, and for keeping the young during the critical period of their early life.

The invention and use of this apparatus, and the treatment of the eggs and young of the ostrich by Mr. Douglass, have added a most important industry to the world, and, in addition to averting the threatened extermination of this species, have greatly multiplied its numbers and increased the supply of its feathers for commercial purposes. These can now be taken year by year from the same (domesticated) bird, instead of involving its destruction for a single crop.

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20. **Göteborg Machine Manufacturing Co. (Limited), Göteborg, Sweden.**

STEEL PLOWS.

Report.—Commended for good workmanship, and fitness for their intended purpose.

SIGNING JUDGES OF SUPPLEMENT TO GROUP XXIII.

The figures annexed to the names of the Judge indicate the reports written by them respectively.

H. K. OLIVER, 1, 4, 6, 7, 18.
M. WILKINS, 2, 3, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17.
J. FRITZ, 8, 20.
SPENCER F. BAIRD, 19.

United States Centennial Commission.

INTERNATIONAL EXHIBITION,

1876.

REPORTS AND AWARDS

GROUP XXIV.

EDITED BY
FRANCIS A. WALKER,
CHIEF OF THE BUREAU OF AWARDS.

PHILADELPHIA:
J. B. LIPPINCOTT & CO.
1877.

SYSTEM OF AWARDS

[*Extract from Circular of April* 8, 1876.]

Awards shall be based upon written reports attested by the signatures of their authors.

The Judges will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the Commission of each country and in conformity with the distribution and allotment to each, which will be hereafter announced. The Judges from the United States will be appointed by the Centennial Commission.

* * * * * * * * * * *

Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Each report will be delivered to the Centennial Commission as soon as completed, for final award and publication.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress, and will consist of a diploma with a uniform Bronze Medal, and a special report of the Judges on the subject of the Award.

Each exhibitor will have the right to produce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

ORGANIZATION AND DUTIES OF THE JUDGES.

[*Extract from Circular of May* 1, 1876.]

Two hundred and fifty Judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the Groups to which they have been respectively assigned. The foreign members of this body have been appointed

by the Commission of each country, in conformity with the distribution and allotment to each, adopted by the United States Centennial Commission. The Judges from the United States have been appointed by the Centennial Commission.

To facilitate the examination by the Judges of the articles exhibited, they have been classified in Groups. To each of these Groups a competent number of Judges (Foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the Departments of Agriculture and Horticulture, which will form temporary exhibitions, have been arranged in special Groups, and Judges will be assigned to them hereafter.

The Judges will meet for organization on May 24, at 12 M., at the Judges' Pavilion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

The Judges assigned to each Group will choose from among themselves a Chairman and a Secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a Judge in each Group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed, by a majority of the Judges in such Group.

The reports of the Judges recommending awards based on the standards of merit referred to in the foregoing System of Awards, must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the Judges on the subject of the Award, together with a Diploma and a uniform Bronze Medal.

Upon matters not submitted for competitive trial, and upon such others as may be named by the Commission, the Judges will prepare reports showing the progress made during the past hundred years.

Vacancies in the corps of Judges will be filled by the authority which made the original appointment.

No exhibitor can be a Judge in the Group in which he exhibits.

An exhibitor, who is not the manufacturer or producer of the article exhibited, shall not be entitled to an award.

The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the Judges. Upon request, he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the Commission relating to awards, subject to an appeal to the Commission.

A. T. GOSHORN,

Director-General.

[*Extract from Director-General's Address to Judges, May* 24, 1876.]

"The method of initiating awards which we have adopted differs in some respects from that pursued in previous exhibitions. In place of the anonymous verdict of a jury, we have substituted the written opinion of a Judge. On this basis awards will carry the weight and guarantees due to individual personal character, ability, and attainments, and to this extent their reliability and value will be increased. It is not expected that you will shower awards indiscriminately upon the products in this vast collection. You may possibly find a large proportion in no way raised above the dead level, nor deserving of particular notice. The standard above which particular merit worthy of distinction begins is for you to determine. In this regard I have only to express the desire of the Centennial Commission, that you should do this with absolute freedom, and when you meet with a product which you consider worthy of an award, we desire you to say, in as few words as you may deem suitable, why you think so.

"This, gentlemen, is all we ask of you in the Departments of Awards. Opinions thus expressed will indicate the inherent and comparative merits, qualities, and adaptations of the products,—information which the public most desires.

"Elaborate general reports and voluminous essays, though of great value as sources of general information, give little aid in determining the reliable or intrinsic merits of particular, individual products.

"The regulations which have been published divide the work of awards into three parts:

"1st. The individual work of the Judges.

"2d. The collective work of the groups of Judges.

"3d. The final decisions of the United States Centennial Commission in conformity with the acts of Congress.

"Each award will thus pass three ordeals, which, doubtless, will be ample and satisfactory."

GROUP XXIV.

JUDGES.

AMERICAN.

C. B. White, M.D., New Orleans, La.

J. H. Thompson, A.M., M.D., Washington, D. C.

FOREIGN.

W. A. Roth, M.D., Surgeon-General German Army.

Dr. Ernst Fleischl, Austria.

GROUP XXIV.

INSTRUMENTS AND APPARATUS OF HYGIENE, MEDICINE, SURGERY, PROSTHESIS, ETC.

CLASS 272.—Medicines; officinal (in any authoritative pharmacopœia); articles of the materia medica; preparations, unofficinal.

CLASS 273.—Dietetic preparations, as beef extract and other articles intended especially for the sick.

CLASS 275.—Instruments for physical diagnosis, clinical thermometers, stethoscopes, ophthalmoscopes, etc. (except clinical microscopes, etc., for which see Class 324).

CLASS 276.—Surgical instruments and appliances, with dressings, apparatus foı deformities, prosthesis, obstetrical instruments.

CLASS 277.—Dental instruments, appliances and materials.

CLASS 278.—Vehicles and appliances for the transportation and relief of the sick and wounded, during peace and war, on shore or at sea.

Mineral waters.

GENERAL REPORT

OF THE

JUDGES OF GROUP XXIV.

INTERNATIONAL EXHIBITION,
Philadelphia, 1876.

PROF. FRANCIS A. WALKER, *Chief of Bureau of Awards:*

SIR,—I have the honor herewith to transmit the report of the Judges of Group XXIV., on Medicine, Surgery, and Prothesis.

Respectfully yours,

J. H. THOMPSON,
Secretary Group XXIV.

GROUP XXIV.

MEDICINE, SURGERY, PROTHESIS.

Much complaint was made by exhibitors in this group of the arrangements at the International Exhibition held at Vienna, in 1873. Medicine, with its allied industries, was there almost ignored; not one of the twenty-six groups into which the entire Exhibition was divided being exclusively reserved to that science. Most of the objects pertaining to the various branches of medical science were exhibited under Groups III., IV., XII., XIV., XVI., XVIII., and XXVI. Thus divided into different classes, it was difficult to trace and impossible to compare them.

The International Exhibition of 1876 gave no cause for complaint on this ground, for not only was abundant space afforded for the full display of every article worthy of exhibition, but the grouping and classification were so admirably arranged as to afford every facility for general examination and comparison.

The system of awards adopted by the Commission was new, but worked satisfactorily. The responsibility for the recommendation for an award rested where it properly belongs,—with the Judge who made it; as, over his own signature, he has to state the reasons for the judgment given, thereby rendering the award of more value to the exhibitor, and ultimately of benefit to the public.

The awards recommended in this group have been comparatively few, for it was considered by the Judges that if the awards were to be of any value to the public, in assisting them to discriminate, and to the manufacturer, as an indorsement of proficiency in his art, they should be based on real as well as comparative merit. For example, three or more exhibitors might display products of their own manufacture, none of which possessed real merit, but of which one was comparatively better than the other. In such instances neither exhibitor was entitled to an award, and none received a recommendation for one; but, where the same number of exhibitors competed, and the exhibit of each possessed real merit, differing in character and degree,

each received a recommendation for an award, the grounds for such award being distinctly stated.

The Judges of this group are indebted to Drs. Hills, of Washington, and Keyser, of Philadelphia, who were appointed by the Commission at the unanimous request of the Judges of this group to assist them in the examination of the exhibits belonging to their respective specialties.

The exhibits under Group XXIV. were many and diversified, and, with very few exceptions, comprised contributions from every nation represented at the Exhibition. America was largely in the ascendant, particularly in surgical instruments, prothesis, and pharmaceutical compounds. This may be readily accounted for. Exhibitors send their products for competition as a matter of commercial speculation as well as pride, and can scarcely be expected to prepare a large exhibit and send it at great expense thousands of miles unless they expect to realize profit by the outlay. The duties upon foreign goods, particularly those coming under this group, are necessarily large, and in some instances nearly equal to the cost of production; and unless they possess some peculiar merit, or cannot be manufactured here, but little advantage would be gained by competition in this market. The almost entire absence of exhibits from the French, English, and German manufacturers of surgical instruments was particularly noticeable, and may in a measure be accounted for by the reasons just given, and by the further fact that simultaneously with this Exhibition was an Exposition at Berlin of the principal manufacturers of surgical instruments and appliances. They naturally sought their own market, as affording more decided prospects of success.

England was represented by one manufacturer of surgical instruments only, and that one a German firm. In the French department we missed the familiar names of Laer Charrière (now Robert & Collin), M. Marthieu, and M. Galante. There was not one exhibitor of surgical instruments proper. Germany sent nothing of importance. We looked in vain for Leiter, Reiner, Thurrigel, Windler, Blumberg, and Weber. America demonstrated, by the magnificent displays of Tiemann & Co., J. A. Gemrig, Codman & Schurtleff, Teufel, Kolbe, and others, that in this line of industry she is able to compete successfully with the most celebrated manufacturers of the Old World.

Before entering into a description of individual exhibits, as marking the special progress made in the arts within the last century, it may be appropriate to refer to the general exhibits under this group by the different nations represented.

ARGENTINE REPUBLIC.

In pharmacy there was nothing of interest, the display consisting of a large collection, so far as variety was concerned, of medicinal roots, barks, and leaves indigenous to that country. The exhibit was without scientific interest, the common name of articles exhibited being used only, and no attempt having been made at classification. One was recommended to be used externally as a remedy for phthisis pulmonalis; another was supposed to be valuable, the decoction being used to strengthen the eyesight; others as purges, tonics, etc.; but the larger part had no therapeutic properties associated with them. One exhibit of an artificial leg and arm was all that came under prothesis. These were very well made, showing considerable ingenuity and excellent workmanship.

CHILI.

A few pharmaceutical preparations came from Valparaiso, and some dried leaves and herbs, for part of which special medicinal virtues were claimed.

PERU.

The visitor would naturally expect to find among the exhibits in this department a fine collection of cinchona bark, but diligent search was only rewarded by disappointment; not one grain of the bark was to be found. Mummies, in a dilapidated condition, were in painful abundance. One small jar claimed special attention; it contained some dried leaves of the world-renowned "coca." For this plant the natives claim most wonderful power; it is said and believed by them that those who partake of it fear neither heat nor cold, hunger nor thirst; poverty has no horrors; in the deep sleep which follows the soul revels in Elysian fields, and enjoys to the fullest extent the extreme of pleasure which the most fertile imagination of an epicure can depict. It is said to be scarce and costly.

NORWAY.

This country sent a large exhibit of cod-liver oil from different manufacturers, no less than eight firms being represented. The world-wide reputation of Peter Moller has undoubtedly induced many others to enter into this branch of industry. All the specimens were exceedingly fine; from the color, taste, and odor, it was evident that none but fresh livers were used in their manufacture. Unfortunately, chemistry has furnished as yet no absolute test for the purity of cod-liver oil. In the examination made of all the samples of oil coming

from this country, not one specimen was found to which a suspicion of impurity or adulteration could be attached. In the entire Exhibition there was but one manufacturer whose oil would bear the test of comparison with the Norway oils, and that was Marvin Brothers, of Portsmouth, New Hampshire. A very compact little medicine-case was exhibited by H. S. Dilton, of Christiania; it could be carried in the pocket, and contained everything necessary for an emergency, and may be said to be valuable to tourists.

CHINA.

China had but one entry under the head of medicines, but it embraced 750 different articles, officinal and unofficinal, and in the Chinese sectional catalogue occupied 35 pages of description. The exhibit was from the Imperial Maritime Customs. This exhibit was not examined by the Judges officially, as it was not unpacked until after their work was completed. For want of room in the Main Building it was placed in the Annex.

Passing over a few of the standard medicines of the world, such as opium, rhubarb, aloes, etc., the specimens of which were poor and possessed no special interest, we found a long array of articles more calculated to surprise and to amuse than to instruct.

JAPAN.

A microscope and some slides, and a few surgical instruments of inferior workmanship, were shown. There were also about twenty diagrams representing skin diseases; and a few chemicals completed the list. Within the last few years a Medical College has been established at Tokio; the lectures are delivered in German; a preparatory school is connected with it; and the class numbers between five and six hundred. From the natural aptitude of this remarkable people we may expect, in the course of a few years, a wonderful advance in the arts of medicine and surgery.

PORTUGAL.

The principal exhibits under this group from that country were mineral waters, of which there were several. For all of these extraordinary virtues were claimed: such as "incontestable for disease of the organs of digestion, and indubitable in curing every variety of skin disease," etc. A display of pills and other nostrums completed the list.

TURKEY.

The samples of gum tragacanth cannot be surpassed, if equaled, the finer specimens being large white flakes, free from any impurity.

The collection of scammony was of an equally high grade. The large, beautiful, and costly exhibit of gum opium was of so high a standard that successful competition from any other source was out of the question. These three articles only were exhibited from this country in the line of pharmacy.

SPAIN.

A small display of artificial teeth came from three mechanical dentists; an apparatus for finishing pills; a blepharatome and a uteroscope. There was also a large collection of nostrums and mineral waters, with a few standard pharmaceutical preparations.

RUSSIA.

The Crown Surgical Instrument Manufactory exhibited a complete army outfit of surgical instruments of excellent workmanship. Doctor Wywodzef, of St. Petersburg, submitted for examination a most complete apparatus for embalming, with the preparation used; as also a specimen of a child's arm which had been embalmed for several months; the flesh and skin were natural in color, plump, and looked as if the limb might have been recently removed from the living body. It was entirely free from odor. There were three separate exhibits of artificial dentures, and appliances for the correction of deformities of jaws and palates.

GREAT BRITAIN.

Here were seventeen exhibitors under the head of Medicine, Surgery, and Prothesis. One very creditable exhibit of surgical instruments was sent by Mayo & Meltzer. Lynch & Co. sent a good assortment of druggists' sundries, and the remainder was divided between diet for invalids, surgical bandages and dressings, and a few unimportant pharmaceutical preparations. Dental art was not represented. Artificial mineral and aerated waters were in abundance, and, although not strictly under Group XXIV., were referred to us for examination.

New Zealand, New South Wales, Victoria, South Australia, and the Cape of Good Hope were not represented in this group.

JAMAICA.

One Government exhibit from the Botanical Gardens, Kingston, of cinchona barks, jalap, senna, aloes, etc.

BERMUDA.

One exhibit of indigenous medicinal roots, herbs, etc.

BRITISH GUIANA.

One exhibit of drugs and medicines, the product of the colony.

INDIA.

Dr. J. Forbes Wilson, the Director of the India Museum, exhibited a very choice collection of barks, opium, aloes, and a large number of other medicinal products from Madras, Bombay, Calcutta, and other parts of India.

CANADA.

Three pharmaceutical exhibits, one display of trusses, and an artificial limb comprised the extent of representation from this country.

FRANCE.

The *pharmacopœa elegans* of Parisian pharmaceutists was well represented. Among the twenty exhibitors under this class were the well-known firms of Vie, Garnier, & Co., Limousin, Rigollet, & Co., and Torchon & Co. The display of rubber surgical instruments was remarkably fine. The three manufacturers in competition have reason to congratulate themselves on their beautiful exhibits. Of surgical instruments proper there was no exhibit.

AUSTRIA.

Three dental exhibits and one of leather trusses. Politzer, of Vienna, exhibited some remarkably fine anatomical and pathologico-anatomical preparations.

SWITZERLAND.

Nothing but goat's-milk, condensed or mixed with some farinaceous preparations.

NETHERLANDS.

At the Vienna Exhibition the Committee of the Red Cross made a valuable exhibit of hospital cars, and all the most approved modes of conveyance for the sick and wounded during war; they, however, contented themselves with sending here a very able report of what they exhibited then, and contributed nothing in addition but plaster and bandages.

NETHERLANDS EAST INDIA COLONIES.

These colonies sent alkaloids of cinchona bark, quinium, quinine, quininodine, cinchonine, cinchonidine, cinchona powder, catechu, and some other native gums.

SWEDEN.

A large exhibit of mechanical gymnastics, illustrating what is known as the Swedish movement cure; also, an excellent collection of surgical instruments for military use, from the Sanitary Department at Stockholm.

ITALY.

Here was nothing of pharmaceutical interest, the contributions in this department being mostly nostrums. Ample amends were made by the beautiful dental exhibit from Noel Wenderling Bros., of which a full account is given under the head of *Dentistry.* There were also a few surgical instruments.

Tunis, Egypt, and the Grand Duchy of Luxemburg were searched in vain for a single object of medical interest.

BRAZIL.

This was the first time this interesting country had entered into competition with the great nations of the world at any International Exhibition, and it was a matter of surprise as well as satisfaction to find how successful her maiden effort was.

Her pharmaceutical display, although not large, was varied, and every article exhibited intrinsically good. One feature in particular attracted the attention of the Judges, viz., the absence of any nostrums or secret remedies; each preparation was made in accordance with some recognized standard established by the regular profession. The whole exhibit was highly creditable, and indicative of an advance in this department far ahead of many countries much more pretentious in their general exhibits. The standard of medical education in Brazil is unsurpassed; the profession is surrounded by safeguards which effectually shut the door against the admission of charlatans or uneducated men.

There are two faculties of medicine in the capital of the Empire, and another in the province of Bahia; both pursue the same course of studies, comprising the following subjects: physics in general, but particularly in its application to medicine; chemistry, organic and inorganic; descriptive and comparative anatomy, general pathology, surgical anatomy, therapeutics, materia medica, hygiene, medical jurisprudence, midwifery, mineralogy, botany, and zoology. The studies are extended over a period of six years, and the subjects divided among twenty-one cathedrated professors and fifteen assistants, appointed by the Government after a competitive examination. Each faculty has a chemical laboratory, cabinet of physics, of natural

history, of anatomy, of materia medica, and a pharmaceutical laboratory. The faculties have a three years' special course of studies in pharmacy for the education of druggists, which comprises physics, chemistry, mineralogy, botany, organic chemistry, materia medica, and general pharmacy. To matriculate in the medical course, the student must have passed a satisfactory examination in Latin, French, English, history, geography, rational and moral philosophy, arithmetic, algebra as far as equations of the first degree, and geometry. For the pharmaceutical course, the student must pass an examination in arithmetic, Latin, geometry, and French. A special course of two years is given for licentiate of midwifery at the Hospital Santa Casa da Misericordia; and before admission the student must pass an examination in arithmetic, reading, writing, and French. When such requirements are demanded before matriculation, and a punctual attendance upon the full course of lectures for a period of six years is required, and then, when the course is completed, a public examination of the strictest character, before graduation, is held, it may be reasonably supposed that among men who successfully pass this ordeal there will be jealous guard kept over the ethics of a profession they have labored so hard to master, and which it will be their ambition to adorn. With the physician thus educated, the druggist a competent and scientific man, and the midwife intelligent and possessed of knowledge adequate to the duties she has to perform, a profound respect from the masses necessarily follows, while quackery and secret nostrums find no support.

The Rio de Janeiro Hospital and Lunatic Asylum are not surpassed by any in the world. In the year 1875 there were 14,512 persons treated in this institution, of whom 9617 were foreigners of all nations and religions. The mortality was 14 per cent., but the larger number of those who died were patients suffering from yellow fever, who died within twenty-four hours after admission; if these were deducted, the mortality would be below 4 per cent.

The Lunatic Asylum—the Hospital Dom Pedro II.—had 390 patients during the same year. They are both under charge of the Sisters of Charity of St. Vincent de Paula.

The Santa Casa da Misericordia, besides the establishments mentioned, the separate infirmaries which it maintains and those which it immediately creates when any epidemic assumes large proportions, has established four consulting-rooms or dispensaries in different parts of the city and suburbs, where medical aid and medicines are furnished to the suffering poor free of charge; to these are attached a staff of medical officers, who visit such of the sick as are unable to come

to the dispensary. The out-door visitations last year numbered 10,354.

Asylums, foundling institutes, reformatories, and indeed all charitable institutions, receive the fostering care of the Government.

UNITED STATES.

In the exhibits included in Classes 272 to 278, the United States more than made up the deficiencies of other countries. The first impression experienced by the uninitiated in passing through that portion of the Main Building occupied by the United States must have been that we were a nation of cripples and hypochondriacs; wherever you went, whichever way you turned, the eye rested upon some mechanical contrivance in the shape of trusses to support ruptures, splints, simple and complicated, to retain adjusted fractures, orthopedic instruments to strengthen crooked legs, deformed feet, and curvatures of the spine, wooden legs for the maimed, artificial arms, hands and fingers, to substitute natural deficiencies or parts lost by accident, crutches for cripples, chairs for the paralyzed, beds for invalids, health-lifts for the weak and sickly, artificial eyes, electric apparatus for the paralytic, and teeth for the toothless. In pharmacy the display was large and beautiful. The exhibits of pharmaceutical chemicals by Powers & Weightman and Rosengarten & Son were exhaustive, and gave more satisfactory evidence of the vast progress made in this branch of industry during the last half-century than the most elaborately written treatise could accomplish. Pharmaceutical compounds exceeded in numbers and value the display of all other nations combined. Vast arsenals of pills, compressed, sugar-coated, and covered with gelatine; tempting elixirs in which the nauseous drugs were so well masked that the compounds were preferable in taste to the seductive absinthe or the aristocratic curaçoa; simple and compound fluid and solid extracts of every drug that would yield its virtues to the universal solvent-water; plasters, powder, suppositories, and an almost endless list embracing every officinal compound. With the single exception of Brazil, this country stood alone in the absence of nostrums or patent medicines, but one manufacturer offering his goods for competition.

The exhibit of surgical instruments embraced all the newest inventions, were perfect in construction and finish, and demonstrated beyond question that the products of the manufacturers in this country were fully equal, if not superior, to those of any other nation.

DENTISTRY.

Egypt, the "mother of the arts and sciences," was the first nation of the world to adopt dentistry as a specialty of medicine. How far the specialists of that remote period had advanced in the art is not known, but Herodotus (500 B.C.) notices the division of medicine into equal branches, among which was dentistry, and to only one of which was the physician allowed to devote himself. Abundant evidences, however, are to be found that the ancients understood the art of filling teeth with gold, and of the manufacture and insertion of artificial teeth.

The museums contain mummies from Thebes with gold-filled teeth, and artificial teeth of sycamore-wood set in gold; but the most perfect specimens demonstrate that the art was in its infancy. Coeval with medicine, but little apparent progress was made until within the last century, during which period dentistry has outstripped every other branch of medicine, and now stands before the world as a specialty equal in importance to any branch of surgery; indeed, it may claim what medicine cannot,—to have risen from an art to the dignity of a science.

Prior to 1776 there was no dentist, so called or practicing as such, to be found in this country. All operations for extraction were performed by the general practitioner or surgeon ; and the principal, indeed, almost the only instrument used was that instrument of torture, the "key," with its adjuncts, the "punch" and "elevator." Prior to the time of Dr. Randall, who died in 1843, forceps were not known as an article of commerce, although he used them. Pain was the indication for extraction, and ruthlessly was it enforced; fracture of the alveolus or jaw was more the rule than the exception.

In 1776, Mr. Wooffendale, a pupil of Thomas Berdmore, of London, arrived in New York, but, although he was the only man in the country who devoted himself exclusively to this branch of surgery, so little did the public appreciate his services that in 1778 he returned to England, being unable to secure sufficient business here to support him. We next hear of Joseph Le Maire, of whom Dr. James Gardette speaks as an eminent dentist in Philadelphia in 1784. Isaac Greenwood was the first dentist in Boston; he practiced before 1784, at which date his son, the celebrated John Greenwood, commenced practice; he was dentist to George Washington, and constructed artificial dentures for him.

Next in order comes Josiah Flagg, an itinerant dentist, in 1785

The following is an extract from his circular: "Dr. Flagg transplants teeth; cures ulcers; and eases them from pain without drawing; fastens those that are loose; mends teeth with foil or gold to be as lasting and useful as sound teeth; and *without pain in operation;* makes artificial teeth and secures them in an independent, lasting, and serviceable manner. . . . Sews up harelips and fixes gold roofs and palates, greatly assisting the pronunciation and swallow. . . . Cuts the defects from teeth, and restores them to whiteness and soundness, without saws, files, or acids, and such abusives as have crept into the profession and which have destroyed the confidence of the public. Sells by wholesale and retail dentifrices, tinctures, chewsticks, masticks, teeth- and gum-brushes suitable for every age, complaint, and climate, with instructions for their use."

In 1783, James Gardette, who was a surgeon in the French navy, came to this country and settled in New York, but removed to Philadelphia in 1784, and continued there in successful practice for forty-five years. He was the first to substitute flat clasps for ligatures or wires; he introduced the "mortise plate," to which the teeth are secured by pins. The first application of the principle of suction or atmospheric pressure has been attributed to him.

Dr. Horace Heyden commenced the practice of dentistry in Baltimore in 1804. He was a man of great energy, and made up for the deficiencies of his early education by hard and successful study. Appreciating the importance of the profession he had adopted, and realizing the necessity for a higher standard of scientific attainment by its members, he joined a number of gentlemen in petitioning the Legislature of Maryland in 1839 to establish a Dental College, "the faculty to consist partly of medical practitioners and partly of dentists." The institution was established, and, at the age of seventy, he assumed the duties of the chair of Dental Physiology and Pathology. Dr. Heyden was also one of the founders of the American Society of Dental Surgeons; was elected its first president in 1840, which office he continued to hold until his death, in 1844.

From this time dentistry has made rapid strides, until it now numbers among its practitioners some of the most scientific and enlightened men in the country. From a mere itinerant pursuit it has arisen to a position equal to any branch of the medical profession, and is decidedly the most lucrative of all.

The system of instruction in the various colleges is comprehensive, and the requirements necessary to be complied with before one can enter upon the regular practice of dentistry are such as to insure intelligence and more than average ability.

ARTIFICIAL TEETH.

When dentistry was in its infancy, artificial teeth were made of bone, teeth of cattle and sheep, hippopotamus tusks and teeth, elephant and other ivories. Human teeth were also used for transplanting, and for pivot-teeth. The use of human teeth for transplanting was confined to the incisors and molar teeth. When one of these was lost, it was replaced by a similar one, taken from the mouth of a healthy person who was willing, for a consideration, to part with it.

In an advertisement inserted in a Philadelphia newspaper in 1784 M. Le Mayer, a dentist, offers *two* guineas for sound teeth, to be obtained from "persons disposed to sell their front teeth, or any of them."* This practice is occasionally pursued to the present date. In a paper recently published in Washington, D. C., was an advertisement, inserted by a prominent dentist of that city, for a sound front tooth for transplanting. When not used for transplanting, the portion used by dentists was the part of the tooth covered by enamel, and called the crown; the operation was known as "pivoting." I cannot describe the process better than by using the language of Robert Wooffendale, to whom reference has previously been made. He says in regard to this operation, "Another method of supplying the loss of teeth by art is by fixing the crown or enameled part of a sound human tooth to the root of a tooth of which the enameled part is wholly, or in part, decayed or broken. This is done by filing each properly, and uniting them by the assistance of a screw of gold or silver, which may be done so completely that it is sometimes not without difficulty they can be separated, in some instances rendering good service for several years; provided the orifice in the root of the tooth, through which the nerve passes, is not much decayed. This operation can only be performed when the teeth have but one root; neither can it be practiced when the root of a tooth is out."†

Benjamin James, in 1814, says, "Dentists pursue very different methods of fastening the new crown upon the roots; some drive the wire, which is attached to the crown, into the canal of the root, with cotton wrapped around it to make it tight; while others previously place a piece of wood in the root, and attach a crown to this substance. As the cotton of the former method absorbs and retains the saliva, which, from stagnation, becomes offensive, and as teeth set in

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* Watson's *Annals of Philadelphia*, vol. i. page 179.

† *Practical Observations on the Human Teeth*, by R. Wooffendale. London, 1782.

this way are sooner loosened, we are induced to prefer the latter manner of setting them."*

Human teeth were also fastened in the mouth by tying them by ligatures of gold or silver wire, silk, unbleached thread, sea-grass, etc. All these methods fell into comparative disuse on the introduction of gold and silver plates fitted with clasps. Strong prejudice existed against the use of human teeth, from a belief that they might be vehicles for introducing disease, and the profession were compelled to seek less expensive and objectionable substitutes, such as hippopotamus and elephant ivory, bone, etc. To all of these there were valid objections, owing to their decomposition when brought in contact with secretions of the mouth.

PORCELAIN TEETH.—Prior to the advent of Dr. A. A. Planton, who arrived in Philadelphia in 1817, porcelain teeth were unknown in this country. They were used in France as early as 1774, and a stock of these teeth was brought to America by Dr. Planton. While in many points they were an improvement, they were still, in their then crude state, very objectionable. They were bad in color and shape, made coarsely and of poor material, white, opaque, and brittle. They were made without gums, being designed for adaptation to ivory or bone bases. In speaking of them, Dr. Flagg says, "The mineral or china teeth are very imperfect; they have an opaque, earthy appearance; are brittle, and the sensation they produce when brought in contact with the natural teeth in mastication is very disagreeable."†

There is much confusion as to the priority of claim for their manufacture in this country, but it is generally conceded that the credit belongs to Dr. Planton. He commenced manufacturing about 1819, and, in 1822, exhibited his work before the Medical Society of Philadelphia, and received from it a certificate of approbation.

Next following was Mr. Charles W. Peale, a man of extraordinary mechanical ability; first a saddler, then silversmith, watch-maker, dentist, and lastly portrait-painter, in which latter vocation he acquired his most enduring reputation. He was public-spirited and given to scientific research. His first teeth (1822) were made with holes through them for riveting to the plates, as he had been accustomed to do with teeth made of animal substance. These, however, proving inefficient, he placed platinum wire in the composition before firing it.

Samuel Stockton commenced his experiments in 1825. He was the first in this country whose manufacture of porcelain teeth attained

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* *Treatise on the Management of the Human Teeth*, by Benjamin James, M.M.S.S. Boston, 1814.

† *The Family Dentist*, by Josiah Flagg. Boston, 1822.

to any commercial importance. Most of those who manufactured previously did so to supply their own wants. His manufacture was the most extensive in this country up to 1845, his production reaching as high as five hundred thousand per annum. His bodies were opaque and uniform in color throughout their whole extent; the gum enamel was a smooth paint, applied on the surface before final vitrification of the teeth; the grinding surfaces of the bicuspids and molars were formed by a three-sided file, in single or crossed grooves; each tooth was of uniform thickness from side to side, no attempt being made to preserve an unbroken lingual surface, in entire dentures, by shading the thin incisors into the broad molars, through a gradual thickening of the intermediate teeth. He gained several premiums in competition with his contemporaries.

James Alcock and D. C. Ambler both gained considerable notoriety and established large manufactories.

To Elias Wildman, of Philadelphia, must be accorded the honor of first reducing the manufacture of artificial teeth to a scientific basis. His labors resulted in the production of a tooth more life-like in appearance than any previously made; he far outstripped his rivals.

Mr. S. S. White, now the largest manufacturer of artificial teeth in the world, commenced the production of his teeth, in a very small way, in the garret of a dwelling-house at the corner of Seventh and Race Streets, Philadelphia. The improvements with which he stands credited are numerous and valuable. He claims to make over four million of teeth annually.

Mr. H. D. Justi, of Philadelphia, in 1852, first had his attention called to artificial teeth, having at that time obtained a thorough knowledge of the manipulation of metals, and especially of steel, for the manufacture of surgical and dental instruments, in which he had served his time in Germany with one of the best experts. After his arrival in this country he entered into an engagement with a house of great reputation for the manufacture of surgical and dental instruments. This establishment was the rendezvous of dentists and manufacturers of artificial teeth, for it was here they could obtain everything needed in their line: instruments for dentists, machines for making platina-pins, and tooth-moulds for their manufacture; here they were furnished with teeth as patterns for moulds, and in reality they had a collection of artificial teeth of all the known makers of the world, and here it was that his study commenced,—carving teeth in metal. Having been successful in this branch of the business, he felt a desire to advance in the art of artificial dentures, and therefore engaged himself with one of the leading dentists of Philadelphia, who

was then manufacturing for himself all the teeth required in his practice; they were made in moulds and also in carved blocks, in which branch he took a special interest. His preceptor was expert in taking the articulation, and here it was left for him to do justice to the case,—to carve and to mount the proper type of teeth. He therefore asserts that in this establishment were manufactured the first sectional teeth ever made in moulds, and that these moulds were made by his hands. Having thus obtained the practical knowledge and experience which he thought a manufacturer of artificial teeth ought to have, he pursued his investigations still further in that direction.

Up to about the year 1855, only one kind of teeth had been manufactured,—teeth for gold and silver plate,—and but very little attention had been paid to their construction of form to approach nature. Then a rubber base was introduced, and from that time the entire dental business has been revolutionized. He made a specialty at that time of supplying manufacturers with moulds of sectional teeth. There were then two different modes of manufacturing these teeth, but neither worked to good advantage, one mode being that in which all the colors were put into the mould, and this resulted in bad colors of the gums, owing to the construction of the mould. By the other mode the blue and yellow colors were put into the mould first; then the material was taken out of the mould and carefully put into the first fire to undergo a slight degree of heat, called a "biscuiting," and the gum was next applied with a brush and then fused or burned ready for use. Seeing that in this latter mode there was room for improvement, he commenced to make experiments, and succeeded in constructing moulds suitable to the various formations of the jaws, adopting curved lines in which he could sink any depth around the neck of the teeth to receive the gum color, and temporizing the materials so that in one very easy operation he had the tooth ready to finish. The results created general admiration, the teeth being light in bulk, and remarkably life-like in their appearance, the gums especially so. In order to distinguish this make of teeth from others, he adopted a trade-mark accompanied with his name. This mode of manufacturing artificial teeth has since been copied by all other manufacturers.

Since the manufacturing of artificial teeth, especially of sectional teeth, has been brought to such perfection, dentists no longer make the teeth they require. They can nowbe supplied by the manufacturer, at less cost to themselves, with a more suitable article better adapted to the case, whatever it may be. To carve an upper and lower set of teeth in a dentist's laboratory would consume the best

part of one day, besides the great inconvenience of getting the furnace ready to burn this single set. Now, one man, in a factory, can produce fifteen full sets in a day, and in one furnace can be burned at one firing two hundred and fifty full sets, or about seven thousand teeth.

Tooth-moulds are made by first taking an impression of natural teeth, the shape and size desired, and then comes the task for the carver, to be able to extend each tooth in size and yet retain the same style and character, when finished, as the natural tooth, as the materials shrink or diminish nearly one-third in size while in the fire. Teeth are modeled in plaster of Paris, in two sections, the outer side and the inner side; from these, castings are taken in hard brass metal, then filed and carved again after the original impression, and are then ready for use. The large number of moulds thus required can hardly be imagined by those not familiar with this business, until they consider the great multitude of people, no two of whom have faces alike.

After having taken good care in imitating nature in her great variety of forms by reproducing these in moulds, the manufacturer has to commence the study of compound materials which he finds in the combinations of feldspar, silex, or silica, kaolin or alumina, from which minerals he receives clearness and strength according to the proper proportions. From the above-named minerals the clearest crystals are selected, finely pulverized, and colored. Colors are received from the oxides of gold, platina, cobalt, manganese, uranium, and titanium; from each single color and its combinations is obtained an endless variety of shades and tones; each manufacturer having his own mode of compounding.

BASE-PLATES.

Previous to 1784 ivory and bone were the materials used for the base-plates of artificial teeth; but both were subject to many objections. Only the greatest care, skill, patience, and experience could, with these materials, produce results having much accuracy of adaptation, or securing ease and comfort to the wearer; and when we add to these the objections applying to the same materials when used as teeth, we can understand with what delight the profession and the public hailed the advent of metallic bases.

Dr. Gardette has the credit of being the first to introduce gold as a base in this country. Gold, being costly, was within the reach of the rich only, and silver was the common and cheaper substitute. Platinum alloyed with silver and iridium has been commonly used, and for a time aluminium was a favorite base. It was first used and pat-

ented by Dr. Bean, and met with much favor, as it withstands the action of acids; but, unfortunately, alkalies destroy it, and it has fallen into disuse. Gutta-percha comes next in order, introduced in England by Edward Freeman about 1851. This, although designed for permanent sets, was found by experience to be available only for temporary dentures, and even for that purpose has long been abandoned. Vulcanite followed. In 1851 the publication of Nelson Goodyear's process for making hard-rubber compounds, afterwards called "vulcanite," turned the attention of many manufacturers to the adaptation of this material, which was announced as a substitute for horn, bone, and ivory, and as susceptible of being colored; but it was several years before the dental profession adopted it.

In 1855, Charles Goodyear, Jr., obtained in England a patent for making a dental plate of hard rubber, in which the teeth were secured before the compound was vulcanized. This was the first recorded or published suggestion of this use of the new material, which contains not only the adaptation of vulcanite, but also the use of the mould as now applied.

The adaptation of the vulcanite had, I believe, been previously made by Cummings, but in his *caveat* of 1852 no mention was made of the mould, and it was not until 1865 that he secured a patent embracing both points. Long and vexatious litigation followed; suits were carried from court to court; and they were finally appealed to the Supreme Court of the United States, where they now await action.

CELLULOID.—In 1870 the Hyatts obtained a patent for converting collodion into a homogeneous and durable compound in masses. This is essentially a mixture of camphor-gum finely comminuted with cellulose fibre. Being naturally colorless, it can be readily colored of any desired tint. It is strong, light, plastic under heat, and elastic when cold. It can be remoulded frequently without injury, and can be repaired easily and promptly, through its perfect welding properties. It is now in extensive use as a substitute for rubber. The principal objection made by its opponents is on account of its highly inflammable nature. Gold, vulcanite, celluloid, and platinum are to-day, as they have been for some years, the principal materials upon which mechanical dentistry depends. The great advance made in instruments and appliances will be referred to in noticing the exhibit of Mr. S. S. White.*

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* In the preparation of this report I am indebted for much of my information on dental progress to the researches of Mr. James E. Dexter, of New York, and have made liberal extracts from the *History of Dental and Oral Surgery in America*, published by S. S. White.

Mr. H. D. Justi exhibited nothing but teeth, but his display was beautiful in the extreme. He claims that all were made by his own hand. In color, translucency, and texture they were all that could be desired; they were a faithful reproduction of the physiological characteristics of the natural organs, both to the individual teeth and relatively to the entire set. Their conformation with reference to close and easy adaptation to the maxillary arch showed careful study of the needs of both patient and operator. Their various and numerous deviations from uniformity of arch and outline, simulating the irregularities of nature, was so perfect that when in the mouth no suspicion of their artificial nature would be entertained. The disposition of tooth-material was so skillfully managed as to secure the greatest amount of strength with the least bulk; and the insertion of platinum pins was so arranged as to render their displacement an almost impossible accident.

The display of artificial teeth made by S. S. White was immense, their variety being only equaled by their beauty. All that has been said concerning the artificial teeth manufactured by H. D. Justi can with strict justice be applied to those exhibited by S. S. White. It does not appear possible that any further improvement can be made; they are as perfect as can be desired. In addition to teeth, this exhibitor displayed a vast museum of every article required by the dentist; an entire day could have been profitably spent in the examination of this costly and beautiful collection. It would be impossible to enumerate all the articles exhibited; I shall, therefore, select a few of the most important, as marking the progress made in the last few years in this important branch of industry. "The S. S. White Dental Chair" is especially deserving of notice, and may be regarded as nearly perfect in all its details. The various positions desired for the patient are obtained with the greatest ease and rapidity. The arm- and body-rest is a valuable addition to the operator, enabling him to prolong his efforts with great comfort and avoidance of fatigue. The head-rest is all that can be desired in variety of motion, firmness of position, and comfort to the patient. A valuable feature of the chair is its adjustable back, which may be easily raised or lowered, or varied in its angle to give support to the body of the patient where most needed, these movements not interfering in any way with the adjustment of the head-rest or seat. The padded seat is exchanged for one of cane in warm weather. The foot-board is self-sustaining at any point in its range, and can be adjusted by the patient. The great improvements effected in the construction of this chair are the remarkably easy and quick adjustment of all or any of its special

parts, and their perfect adaptability, when adjusted as a whole, to meet any requirement of patient or operator. The form, frame, and character of the finish and upholstering leave nothing to be desired.

DENTAL ENGINES.—The dental engine originally introduced by Dr. Morrison, of St. Louis, Missouri, with the improvements since added by this manufacturer, may be considered one of the greatest in importance that has ever been presented to the dental profession. The ease and safety with which operations upon the most delicate teeth are performed completely overthrow the objections offered by those who are prejudiced against the "innovation," as they term it, without being particularly acquainted with its merits. It is absolutely certain that with the aid of this engine operations for excavation can be made almost painless,—a great consideration to the patient.

The almost endless variety of points embrace burs of every shape and size for removing decay preparatory to filling, viz., round, wheel, cone, inverted cone, bud, fissure, square end, fissure-pointed, and oval. In drills there are flat spear point, square, flat-square point, round, twist drills, trephines, five-sided flexible burs, and drills for opening and preparing nerve-canals. Plug-finishing burs are in every variety of shape adapted to every want of the dentist,—Arkansas, Hindostan, and Scotch polishing-stones mounted on mandrels in great variety; boxwood disks, wood-polishing points, corundum points, corrugated and smooth-polishing burnishers, etc., all of which can be adapted.

The right- and acute-angle attachment are valuable additions to the engine, enabling the operator to prepare cavities in the posterior portion of the teeth with great facility. When we view its various uses and manifold appliances, and the vast amount of labor it overcomes, the question naturally arises, How did the dentist ever do without so valuable an instrument?

Before closing this paper, a simple act of justice demands the most favorable notice for the "rubber dam" introduced and presented to the profession by Dr. S. C. Barnum. As an auxiliary to dentistry its value cannot be computed. Operations that were once considered impossible are by its aid made comparatively easy to patient and operator. The absolute dryness which should be secured for all teeth to be filled is by its use attained without trouble, and the complete success of the operation insured. The method of applying the dam is simple. With a plain, suitably-sized punch a hole is made in the rubber, which is then passed over the teeth to be filled, and fastened by a silk ligature, which prevents moisture encroaching upon the

cavity. To Dr. Barnum belongs the honor not only of its introduction but the gratuitous presentation of his simple and valuable invention to the dental profession.

DENTAL MUSEUM—ITALIAN DEPARTMENT.

One of the most instructive exhibitions in the Main Building was the dental museum in the Italian department. It occupied little more space than a medium-sized parlor book-case, but it was complete, containing more practical information for the student of dental art than a whole library. Such a collection must have required years of patient and intelligent labor by masters of their profession, who have spared no pains in accumulating a series of anatomical preparations of the teeth and jaws illustrating most comprehensively their physiology and pathology. The selection of anomalous and pathological cases was of peculiar interest.

The student could find in this museum, either in natural preparations or in wax reproductions, all that a practicing dentist need know, and, by a careful study of the exhibit, complete the knowledge he has acquired theoretically.

The museum was divided into two parts:

1. Descriptive anatomy and physiology.
2. Pathological anatomy, surgery, prothesis, and orthopedy.

The first specimen in the anatomical division showed the almost spherical protuberances which contain the dental gums, or the outer face of the jawbone in a fœtus six months of age.

No. 2 was injected with red wax, showing the same, but more perfectly, from a fœtus of the same age.

In specimens 3 and 4, the external lamella of the right side was removed, showing the somewhat thickened bags, some of which were opened to demonstrate the first period of solidification of the teeth.

The next series explained the progressive development of the temporary and permanent teeth.

a. The degree of development of the temporary teeth three months after birth.

b. The development of the same about the age of two years.

c. Development of the same at four years of age, showing the complete formation of the temporary teeth.

d. The first permanent tooth, age corresponding to *b*.

e. Permanent teeth, age corresponding to *c*.

f. Permanent teeth, replacing the twenty temporary, and complete formation of first molars; age nine years.

g. Age fifteen years, twenty-eight permanent teeth, the last four molars still in a state of formation.

h. Age from sixteen to twenty-five years; the thirty-two permanent teeth complete.

Next in order were exhibits of the left side of the jawbone, exposing the connection between the temporary and permanent teeth, and the disposition of the roots in the alveoli.

Following these were specimens of the jawbones at the age of first teething, after the end of the second teething, and after the loss of the thirty-two teeth; also, the development and disposition of the alveoli in the first and second periods of teething.

Next followed longitudinal and horizontal sections of the twenty temporary teeth, showing:

a. The position and volume of the dental pulp;

b. Longitudinal sections of the thirty-two permanent teeth;

c. Two sections from the teeth of an aged person, in which the pulp is reduced to the minimum of its volume;

d. Horizontal sections of the thirty-two permanent teeth.

The next division was devoted to the microscopical study of the hard substance of the teeth:

e. Enamel (horizontal section of a crown);

e'. Enamel (longitudinal section of a crown);

f. Dentine (section perpendicular to the pulp);

f'. Dentine (section parallel to the pulp);

g. Cementum;

h. Longitudinal section of an entire tooth;

i. Section showing various fissures of the enamel and solution of continuity;

k. Piece of bone for comparative study.

Then followed illustrations of the mouth at different stages of development and at old age, embracing the following instructive divisions:

a. Mouth of child when the first teething is complete, with the twenty temporary teeth;

b. Mouth at five years, showing the first permanent molars;

c. Mouth at fourteen years of age, with total absence of temporary teeth, and presence of twenty-eight permanent ones;

d. Mouth at twenty-five, second teething complete;

e. Mouth of an old subject, with the thirty-two teeth, but worn and shortened by use;

f. Mouth of an old subject after the loss of some teeth, demonstrating the deviations undergone by those left without support, and the modification produced in the articulation of the jaws;

g. Mouth of an old subject entirely deprived of teeth, showing the absorption of the alveolar process.

This completed the anatomical and physiological divisions of the cabinet, each preparation being an almost perfect work of art, and reflecting the highest credit upon the skill and patience of the exhibitors. The pathological department embraced almost every deviation, irregularity, or anomaly of the teeth and gums. Forty specimens were devoted to the demonstration of the various irregularities in the size, shape, length of root, and position of the teeth, depending upon constitutional depravity, arrest of development, and want of proper care at the period of second dentition. Four of these specimens were worthy of special notice; they were marked in the cabinet 69 to 72; Nos. 69 and 70 showed the mouth at the period of second teething; irregular process on account of the position taken in the alveoli by the germs of the permanent teeth. In the upper jaw the central incisors were in their normal place, the right lateral one appeared internally behind the temporary one, without having worn away the root; the first left bicuspid grew quite obliquely, with its crown turned towards the palate, wearing out only partly the roots of the first temporary molar; a protuberance produced by the cuspid, that will appear outwardly without touching with its crown the root of the temporary one, was seen on the gum in the region of the left canine fossa. The lower jaws presented about the same anomalies; 71 and 72 demonstrated irregularity in the curve of the parabola of the jaws and in the number of the teeth. Both in the upper and lower jaw the dental arch was narrow at the sides and much widened at the extremities. There were three upper supernumerary teeth; two, without characteristic form, on the roof of the mouth, one on the gum, between the left central incisor and the lateral one. The left lateral incisor had a double crown, as if another tooth was fixed on its posterior face.

The next series showed the different phases of dental caries, with sections of the cariated teeth of the first, second, and third period showing the cones of resistance, formed by the pulp, towards the caries, and its retraction, so as to detach itself from the invasion of the disease.

Following this were twenty-seven specimens devoted to demonstrations of diseases of the intra-alveolar periosteum, gums, and alveoli, with illustrations of the effect upon the teeth and gums of a departure from the normal alkalinity of the saliva.

Specimen 109 showed the copious deposit of tartar on the outward face of the upper front teeth. The particular color of this tartar and

the partial alteration of the underlying enamel indicated that the saliva in this case is not continually alkaline, but becomes momentarily acid at intervals more or less long, then dissolves the tartar in part and produces with it a chemical combination, which develops carbonic acid and decomposes the enamel. This accidental acidity of the saliva ceases, and the alkali prevailing again, another quantity of tartar is produced, and so forth. The inflammation of the gum caused by the presence of the tartar is well marked.

No. 116 exhibited the effect of tobacco-smoking on the teeth and on mucosa. The teeth are covered by a hard, bright crust of smoke, together with tartar, which clings strongly to the enamel; they are also bared, especially the last molars, the internal roots of which are half bared. The mucosa around the neck is white, spongy, and soft, alteration caused by the continual artificial heat of the smoke, and by the acid and caustic elements found in the tobacco.

Then followed twenty-two specimens of prothesis and orthopedy, embracing pivot-teeth, dentures, complete and incomplete, with and without spiral springs, the various methods of retention by atmospheric pressure and by clasps, and a series of orthopedic apparatus for the correction of congenital malformations of the palate and loss by scrofulous and syphilitic necrosis.

HARD-RUBBER APPLIANCES FOR FRACTURED JAWS AND CLEFT PALATE.

Mr. Thomas B. Gumming, of New York, exhibited a series of splints and appliances for the treatment of simple and compound fractures of the jaw. Prior to 1840, fractures of the jaw were treated principally by bandages and external supplementary contrivances, many of which were more than objectionable. Teeth loosened by the injury were left unsupported, and the motions of the jaw, cheeks, and lips painfully restricted. It is claimed by the inventor that when a well-adapted splint is on the teeth and gums, the other parts around the bone are to a great extent a counter-support to the splint. Thus, the broken jaw, together with any teeth loosened by the injury, is held securely in place until the fractured bone is reunited and the teeth become firm. Meanwhile the motions of the jaw are in most cases unrestricted and the cheeks and lips always left free.

In the use of these splints, fractures of the lower jaw are divided into two distinct classes: 1, those in which the teeth and gum of the fractured jaw are alone used to control the fractured bone; 2, those in which the splint is fitted to both the upper and lower teeth.

Fig. 1 represents a hard-rubber splint which has been moulded for the treatment of a case in the first, or that in which the jaw is left free; it is turned up to show its inner surface, which incloses all the teeth and part of the gum of the lower jaw, and when adjusted in position rests against the upper teeth when the jaws are closed. It is used without any bandages around the head, the jaw being allowed its natural movement during treatment. The holes marked *A* go through the top of the splint, for the purpose of syringing the parts within with warm water during treatment. The dark, round spots in all the cuts represent holes for similar purposes. The cut is taken from a photograph of a splint exhibited by the inventor, who applied it to a fractured jaw in 1862. He claims, and I believe justly, that it was the first splint ever used without an appliance outside the mouth. This splint will control all single fractures which have teeth on both sides; also double, or even comminuted fractures, forward of the bicuspid teeth, when molar teeth are present to hold the back ends of the splint down, and thus keep the front fragments up. This splint is generally used without any fastening, but, with children, and in some cases with adults, it is sometimes secured by screws pressing into the teeth, or by the wings and bands shown in Fig. 4. When screws are used, they pass through metal nuts, sunk in the splint, and the ends of the screw are made smooth where they enter holes drilled into the teeth. In the explanation given by the inventor, he claims that the drilling of the holes does not injure the teeth; they must be filled, however, after the jaw is united.

FIG. 1.

When the jaw is broken so that it is found impracticable to hold the parts until reunited, except by keeping the fractured bone still, the splint, in addition to fitting the teeth and gum of the lower jaw, is made to inclose the upper teeth also, as shown in Fig. 2, where screws may be seen opposite both lower and upper teeth. By this arrangement the fragments of the lower jaw are secured, not only relatively to each other, but also to the upper jaw. *B* is a triangular opening, of which one side corresponds to the cutting edge of the lateral incisor, which tooth stood

FIG. 2.

E
I
E′ *B*

in the end of the fragment most displaced before the splint was applied; *C* is an opening for food, speech, etc.; *D* is a channel for the saliva from parotid gland to enter the mouth, its fellow being seen on the other side of the splint; *E'* is a screw to enter lower canine tooth, the head of the left screw being just discernible; and *E* the head of screw opposite the upper first molar tooth, the end of its fellow being seen on the other side.

It is claimed that this splint is adapted to the treatment of all fractures back of the teeth. In these cases the splint is cut away in front, and extended across the roof of the mouth, when there are upper and lower back teeth to fasten to, and thus give as much room as possible to speak and eat through. Opening the teeth a quarter or three-eighths of an inch would not have any bad effect on the position of the fragments, even if the jaw were broken through the necks of both condyles, as the parts near the fractures would move but little, and the back of the jaw could be raised high enough to keep the broken surfaces in contact.

FIG. 3.

F, upper wing; *G*, lower wing; *H*, mental band to hold the jaw up in the splint; *I*, neck-strap to keep the band back; *K*, balance-strap to hold the cap in place.

Fig. 3 shows wings and caps to which fastenings are adjusted for cases having no teeth in either jaw,—the ends of the wings within the mouth are imbedded in a vulcanite splint similar in principle to that of Fig. 2. The wings are made of steel, and quite light. They have fine teeth along the edges, where the bands and tapes bear, to prevent slipping, and small holes every half-inch to hold the strings, lacing, etc. The arch of the wings is high enough to give the lower lip room for upward movement. The wings for each side of the jaw are in one piece, and the parts within the mouth pass back in the line of the upper gum. They are thinned down and pierced with holes, that the rubber in which they are imbedded may hold them firmly. The tape strings pass from the cap inside and under the upper wings, then up between them and the tape lacings, which keep the strings from slipping to the cap whence they started. The mental band passes up between the sides of the lower jaw and the wings, where it is tied by the strings which pass through the holes. The band is cut off to show this; but when worn it should be turned

down on the outside and pinned just below the wings. The neck-straps should be sewed to the mental band on one side and pinned on the other, and worn tight enough to keep the band from slipping forward over the chin. The jaw and splint are supported by the cap forward of its centre. This is counterbalanced by the elastic strap which passes from the back of the cap down around an unelastic and much heavier strap, extending across and fastened to the shoulders by elastic ends. The balance-strap returns to the cap, and is buckled tight enough to hold the jaw up.

By this arrangement the splint is a resting-place for the broken jaw, while the wings give firm attachment to appliances which hold the jaw up with the least possible pressure upon the external parts, as the wings need not press either against the jaw or the zygoma.

The same exhibitor presented also an ingenious metal splint adapted for the same purpose as the hard rubber. It is made of cast-tin, and is intended to be used with a lining of gutta-percha. It is cast in seven different sizes, from which the desired size can be selected. Fig. 4 represents the splint, which has a handle in front, that it may be used as a cap to take the impression of the jaw; the holes are for the purpose of allowing a small probe to be pressed through the wax down to the teeth, thus allowing air to enter to facilitate the removal of the impression, and, when in use as a splint, to give entrance to warm water, thrown from a syringe, to keep the parts clean. This splint has the advantage of being easier of application than a rubber splint, especially if the fractured bone can be set and held by ligatures firm enough to bear the pressure of the warm gutta-percha; for the splint can then be applied to the teeth, without being first moulded to a plaster cast, and the gutta-percha closing around them keeps the bones in place without further fastening. If the fracture cannot be set firm enough without, a plaster cast must be made. This splint can be arranged to be used like any of the rubber splints, and the wings, if needed, can be soldered on, care being taken that their edges are clear of the corners of the mouth when open.

FIG. 4.

G, wing of malleable iron, projecting with its fellow from the splint to which they are soldered; *H*, mental or splint band, with the end left up to show the manner of tying; *I*, neck-strap.

In connection with the splints shown, was a series of casts illustrating the double-compound fracture of the jaw of the late Hon.

William H. Seward, showing the jaw broken on both sides between the bicuspid teeth. Also, a double cast of the upper and lower jaw as held by the splints for sixty-eight days. As no teeth were left in the upper jaw, the wings and cap were used as shown in Fig. 3. The result was thoroughly satisfactory.

HARD-RUBBER APPLIANCE FOR CONGENITAL CLEFT PALATE.

This contrivance is a very marked improvement over all previous appliances for rectification of this distressing malformation. It was first applied by Dr. Gumming in 1864. These plates, illustrations of which are seen in Figs. 5 and 6, avoid the objectionable features of

FIG. 5.

Cleft-palate plate, lower view. When worn, the back part is covered for the space of a quarter of an inch on either side by the cleft soft palate.

FIG. 6.

Cleft-palate plate, upper side-view of the appliance, suitable for a case in which the cleft does not reach the front teeth.

earlier appliances, and to some extent enable the wearer to utilize the action of the muscles of the cleft velum. The palate is easily made,

and does not deteriorate in the mouth. It is not supported by any part of the cleft, and may therefore be worn from early childhood. The plate which is held up by the teeth against the hard roof of the mouth extends up into the cleft and thence to the back of the pharynx near the tubercle of the atlas, the end being rounded to allow the sides of the pharynx to close during the act of swallowing. This extension into the cleft being spread out over the soft parts on each side, the ununited muscles can draw up against it and close off the nasal cavity. The vowel sounds are therefore preserved from the resonance of the nose by the natural action of the muscles, while the nasal sounds are used when necessary, and the tongue is able to form all the lingual consonants, the stiffness of the hard rubber affording the best possible substitute for the muscular firmness of the natural soft palate. There being no forward action whatever of the superior constrictor muscles, a rigid plate can be worn without intermission, not only in comfort, but with improved condition of the mucous membrane, which is covered in, and of the general health, the nose being as free for breathing as in a normal condition of the parts.

FIG. 7.

Fig. 7 is taken from a photograph of a cast exhibited. The case was one of a large cleft through hard and soft palate in a patient twenty years of age. The cleft in the lip had been closed in infancy. Several unsuccessful attempts had been made to close the soft palate.

Fig. 8 shows the plate as adjusted to remedy the deformity exhibited in Fig. 7. The cut was made from the cast of the plate *in situ*

Fig. 8.

after it had been worn more than four years, day and night. The whole arrangement will be familiar to scientific dentists, as similar contrivances have commonly been made in soft rubber. Over this material the hard rubber has many and marked advantages. I should imagine that celluloid would be preferable to hard rubber, as it is without odor, equally durable, and as plastic for moulding.

ARTIFICIAL LIMBS.

The department of prothesis, which is concerned with the reparation of the loss of the arm or leg, has received the attention of surgeons from the earliest time. Ambrose Paré, in his great work on surgery, which appeared in the latter part of the sixteenth century (1579), not only refers to the artificial limbs which were supplied in his day, but gives detailed illustrations of an artificial arm and leg, and explains fully their construction. The devices were of a very rude character, but they show the early attempt to conceal the mutilation by means of a mechanical substitute made to resemble as nearly as possible the form and motions of the natural member. Paré seems to have recognized it as an important part of the duty of a surgeon

to provide for the comfortable locomotion of the patient after the removal of the limb,—a consideration which, since his day, has been too often overlooked by the operator, who has allowed himself to be guided by surgical considerations alone.

In an article of May 30, 1860, in *Le Bulletin Général de Thérapeutique*, Paris (to which journal we are much indebted), is found the following account of an artificial limb invented by Verduin, a learned Dutch surgeon, in 1696. Verduin gave to the art the model of an

FIG. 1. FIG. 2. FIG. 3.

artificial limb. This limb (Figs. 1 and 2) was composed of a wooden foot, *A*, on which were fastened two pieces of steel, going up to a level with the articulation of the knee.

A copper boot, *B*, incased the stump, and was fastened by rivets to the side-pieces *D*. A thigh-socket, *F*, the anterior part of which incased the small of the thigh, was articulated, by a hinge-joint, with the side-pieces *H*. A chamois stocking (Fig. 3), which enveloped the stump, and went up as far as the superior part of the thigh, was held by the thigh socket, and kept the stump suspended. Finally, to better protect the cicatrice, a soft cushion was placed at the bottom of the metallic boot. Verduin's apparatus depended, as is easily seen, upon the principle that we must seek a point of support upon the segment of the member superior to that which has undergone amputation, instead of taking it at the condyles of the tibia and about the knee, as his fellow-countryman Von Sollingen had done. Unfortunately, Louis did not approve of the principle advocated by Verduin, and so great

was the influence of his authority that all the surgeons of the eighteenth century; those of Italy and England, as well as France, with the exception of Ravaton, endeavored to make their patients walk with appliances taking their point of support around the knee. None of these, despite their varied forms, were found to answer, and more than a century was passed in fruitless attempts.

In 1826, Professor Serre, of Montpellier, returning to Verduin's principle, proposed a new artificial limb, taking its point of support at the small of the thigh.

M. Goyrand opened a new era in the construction of artificial limbs, in changing the point of support to the perineum. This improvement henceforth entered into automatic appliances in current practice, especially in those cases amputated at the inferior third of the limb. In 1831, M. Goyrand (of Aix) had occasion to practice amputation above the ankle upon an individual affected with tubercles, whose condition was ameliorated under the influence of the operation. Shortly afterwards, three new analogous cases were presented to his observation, and the rapidity of the cure, as well as the amelioration of the accompanying injury to the foot, called the attention of that learned surgeon to the question of mechanism. His patients cured, it remained to make them walk as advantageously as possible. M. Goyrand rejected all the models of sockets since Ravaton. He understood that the pressure to which the stump had to submit in this sort of apparatus could not but contort or tear open the cicatrice. Having witnessed the good result produced by an artificial limb worn by a young lady of Brignolles, whose limb had been amputated at the place of election, and whose apparatus had its principal point of support at the tuberosity of the ischium, M. Goyrand resolved to apply a similar one to his patients. The ingenious orthopedist, Mille, inventor of that artificial limb, had it quickly modified to serve for amputation above the ankle. In fact, he merely had to dispose the side-joint in such a way as to incase and hold the long stump of those so amputated.

The apparatus of Mille, in the opinion of the French surgeons, marked an important advance in the art, and led to still further improvements by other makers. His modification for amputations above the ankle rendered that operation popular among the French surgeons, whose favorable attention had been attracted to it by its demonstrated safety.

The annexed figure represents the artificial leg invented by M. Ferd. Martin. Desirous of preventing injury to the extremity of the foot, in walking, M. Martin had the extremity of his new apparatus

raised; he did not perceive that by this modification he had transformed his artificial leg into a peg, and changed the statical condition of the body. His patients could not then walk with a flexible knee,

FIG. 4. FIG. 5.

FIG. 6. FIG. 7.

MARTIN. CHARRIÈRE. BÉCHARD. MATHIEU.

and the limb had to be kept stiff by the aid of a stop-joint. The modification necessary to give flexibility to the knee was so simple that I am astonished that so expert a mechanician as M. Martin remained so long without finding it out. It was merely needful to carry behind the axis the articulation of the shin- and thigh-pieces. The principle stated, the means are found. Do not the springs which hold open the "capote" of our cabs present eccentric articulations enough to offer the greatest resistance? Fig. 4 (see cut) represents the model of M. Martin's; it is his first attempt, that is to say, the extremity of the foot raised, and the eccentric articulation of the shin- and thigh-pieces.

In the artificial leg of M. Charrière (5), as in that of Mille, the foot is preserved, and the movements of flexion and extension of the extremity of the member produced by elastic springs. In the model presented in 1856 to the Société de Chirurgie the extension of the foot is maintained by the action of an artificial muscle, *C*, which from

the heel, *A*, is inserted in the posterior and inferior part of the thigh-socket *D*.

To complete the account of the French limbs, we introduce the annexed cuts of those of MM. Mathieu and Béchard. They have as a base two pieces of steel incased in leather, the foot being held raised by springs as in the apparatus of F. Martin, and, like it, they operate on the principle of the peg.

The official records of French patents show very few grants of protection for artificial limbs. With the exception of M. Martin, none of the inventors whose names occur in the foregoing pages appear to have been protected by patent. In vol. liv. of the old series of French *Brevets d'Invention* will be found the patent of M. F. Martin, dated May 28, 1842. Its chief peculiarities are the gig-top joint placed in rear of the line of gravity of the body, and a fusee spring applied to the regulation of the force of flexion of the limb.

The records of the English Patent Office show a much larger amount of attention given to the subject of artificial limbs. Down to 1865, we find nineteen patents, beginning with that of Thomas Mann, of January 20, 1790. His artificial leg is an ingenious contrivance, and exhibits many of the principles which have since come into use in the best artificial substitutes. It is made of wood, hollowed out in the usual way, and covered with chamois leather. The joints are bushed with leather to avoid noise, and the motions are aided by springs both in the thigh and foot. There is a double socket, one playing within the other, and operating as a device for preventing the flexure of the leg when the weight of the wearer is supported upon it. The leg is superior in simplicity and design to those of Verduin, Mille, and Martin, heretofore referred to, and foreshadows the course of improvement in which perfection in the manufacture was to be sought and realized.

The leg of James Potts, patented in England, November 15, 1800, is that which has since become celebrated as the Anglesea leg, because it was so long worn by the illustrious Marquis of Anglesea. The socket is made of leather. The knee-joint is a hinge provided with a lock to prevent flexion when the weight of the wearer is supported on the artificial limb. The foot is united to the leg by a ball-and-socket joint allowing of lateral motion, and the suggestion of lateral motion, since claimed as a novelty, is distinctly made in the specification. The whole leg is covered and stuffed to give it a natural form and softness to the touch, and the joints are padded to prevent noise. The toe-piece is hinged to the foot in the manner now usual. This invention had much merit, and we believe the limb is still a favorite

in England. An improvement on the Anglesea leg was patented and long manufactured by the late William Selpho, of New York. Before the invention of Palmer, the Anglesea leg of Selpho was the best artificial limb to be obtained in this country.

Thomas Mann, October 31, 1810, patented an improvement on his patent leg of 1790. It consists in the addition of certain springs and cords to give greater naturalness to the movements of the limb at knee and ankle, and to assist the wearer in recovering readily the upright position of the leg after flexure, while allowing the easy retention of the flexed position while in a sitting posture.

William Strand, June 1, 1816, patented a spring joint for giving elasticity to the foot and greater naturalness to the tread.

H. Wilms, May 8, 1817, introduced a new material into the manufacture by making limbs of cartouch-paper and linen interleaved and glued together, the object being to combine lightness and strength.

The celebrated artificial leg of B. Frank Palmer was patented in England in 1849, but we reserve our notice of this maker for another portion of this sketch.

Benjamin Mitchell, April 5, 1853, describes a limb in which the flexion and extension of the leg are effected without internal mechanism, by means of straps attached to a belt around the waist of the wearer, and the action of the limb is controlled by the movements of the hip.

W. C. Fuller, in 1855, describes in a patent for various forms of rubber springs their adaptation to artificial limbs.

J. Ashman, in 1856, suggests the use of hide, papier-maché, and vulcanite in the construction of limbs, and introduces a spiral spring in the heel.

In 1857, W. E. Newton patented, as a communication, an artificial leg in which elastic cords were employed to connect the thigh with the foot, to imitate the action of natural muscles. It also shows an application to the thigh-socket, in cases of amputation above the knee, of a leather sack, made of a form to fit the stump of the natural limb, and suspended at its mouth from the edge of the socket of the artificial one, for the purpose of assisting to support the patient and relieving the stump from the unpleasant and often painful and injurious pressure produced upon it by the ordinary method of supporting it by forcing it into a tapered socket. This seems to be the earliest embodiment in a patented invention of a device for supporting the patient wholly or partially on the end of the stump; but the suggestion had been made years before by Palmer, some of whose patients walked in that way. (See Palmer's *Bane and Antidote*, 1852.)

It was not a mode of support which, when it was first suggested, commended itself to the favor either of the surgeon or the manufacturer of limbs, and it was not until the more perfect devices embodied in Palmer's United States patent of 1873 that this method of supporting the patient received a development which makes it, at the present time, the most remarkable advance in this department of prothesis.

The last English patent we shall notice is that of M. Henry, No. 675, of 1860, which is for a leg made in open-work of light wood, strengthened by stays and metal plates. The joints of the foot are made of leather.

The American Patent Office shows a record of nearly 150 patents for artificial limbs. The Civil War, which caused the mutilation of multitudes of soldiers, and the noble liberality of the Government in making provision for supplying the mutilated with artificial limbs, naturally acted as powerful stimulants to the efforts of inventors to produce substitutes which should command the patronage of the Government. The mass of these patents are either for crude and ill-considered devices, entirely unfitted to supply properly the want they were intended to meet, or for mere details of improvement on recognized inventions.

First, both in time and importance, is the artificial limb of B. Frank Palmer, which was patented November 4, 1846, and improved by further patents in 1849 and 1852. This leg is more widely known, and has met with more general approval by the profession and the public, than any invention of its class, and for that reason we give the detailed notice and description of it from the great work of Velpeau on operative surgery:

"Artificial Legs.—After a patient has submitted to an amputation of his limb, he very naturally inquires of the surgeon what is the best substitute he can suggest to him, and we know that this question has often given rise to much perplexity. As to the lower extremity, we now have it in our power to furnish every desirable information upon this point, and for this we are indebted to Mr. B. Frank Palmer, the inventor of the artificial leg which has won the admiration of the most prominent surgeons in Great Britain, France, and America. During the Great Exhibition in London, 1851, we had an opportunity of inspecting the large number of artificial limbs there presented, and we know that there was but one opinion as to the vast superiority of Mr. Palmer's invention to any hitherto offered. In a word, Mr. Palmer bore away the palm, the adjudicators being, among the rest, no less than the distinguished surgeon of St. Bartholomew's Hospital, Mr. William Lawrence, and the renowned veteran of the Hôtel Dieu,

Roux, recently deceased. We confess that after walking some distance with Mr. Palmer, we did not in the least suspect that he had himself been provided with one of his own artificial limbs, yet such is the fact. This certainly is one of the greatest triumphs of American ingenuity. We copy from a pamphlet issued by Mr. Palmer the description of its peculiarities, remarking, at the same time, that through his politeness and liberality we are enabled to present to the reader an internal view of this beautiful piece of mechanism. We also insert the views of Mr. Palmer, which have special reference to the comfort and usefulness of the mutilated who may desire to avail themselves of his substitute. The articulations of knee, ankle, and toes consist

FIG. 1. FIG. 2. FIG. 3.

PALMER'S PATENT

Internal view. Internal view, semi-flexed. External view.

of detached ball-and-socket joints, *A*, *B*, *C*. The knee and ankle are articulated by means of the steel bolts *H*, *H*, combining with plates of steel firmly riveted to the sides of the leg, *B*, *B*. To these side-plates are immovably fastened the steel bolts *H*, *H*. The bolts take bearings in solid wood (properly bushed) across the entire diameter of the knee and ankle, being stronger, more reliable, and durable than those of the usual construction. All the joints are so constructed that no two pieces of metal move against each other in the entire limb. The contact of all broad surfaces is avoided where motion is required, and thus friction is reduced to the lowest degree possible. These joints often act for many months without need of oil or any attention,—a desideratum fully appreciated by the wearer. The tendo-Achillis, or heel tendon, *F*, perfectly imitates the natural one. It is attached to the bridge, *E*, in the thigh, and passing down on the back

side of the knee-bolt, *E*, is firmly fastened to the heel. It acts through the knee-bolt, on a centre, when the weight is on the leg, imparting security and firmness to the knee- and ankle-joints, thus obviating all necessity for knee-catches. When the knee bends in taking a step, this tendon vibrates from the knee-bolt to the back side of the thigh, Fig. 2. It descends through the leg, so as to allow the foot to rise above all obstructions in flexion, and carries the foot down again, in extension of the leg for the next step, so as to take a firm support on the ball of the foot. Nature-like elasticity is thus attained, and all thumping sounds are avoided. Another tendon, *G*, of great strength and slight elasticity, arrests the motions of the knee, gently, in walking, thus preventing all disagreeable sound and jarring sensation, and giving requisite elasticity to the knee. A spring, lever, and tendon, which combine with the knee-bolt, give instant extension to the leg when it has been semi-flexed to take a step, and admit of perfect flexion in sitting. A spring and tendons in the foot also impart proper and reliable action to the ankle-joint and toes. The sole of the foot is made soft, to insure lightness and elasticity of step. The stump receives no weight on the end, and is well covered and protected to avoid friction and excoriation. Fig. 3 is a view of Palmer's perfect model."

The artificial leg of Palmer has continued from that day to the present to hold the first place in the favor of the public and of the profession. The American surgeons have vied with those of Europe in praise of its excellence. There is scarcely a name eminent in surgery in England, France, or the United States that is not on record as indorsing the merit of this admirable invention. Gross, in his great work on surgery, says, "It would be difficult to conceive of any apparatus more beautiful in its construction, or more admirably adapted to the end proposed, than the artificial substitutes of Mr. Palmer, who obtained the prize-medal at the Great Exhibition in London in 1851. Combining lightness with strength, and neatness with symmetry, they are worn with great comfort and satisfaction, and are apparently as perfect as any piece of human mechanism can be made, the whole arrangement being a close imitation of the natural muscles and tendons, if not in shape at least in position and function. The socket is made with special care, neatly fitting the stump in every portion of its extent, and is well padded to prevent friction and excoriation, the pressure being diffused over the whole circumference of the stump, while the extremity of the latter is perfectly free in the interior of the former."

But admirable as was the Palmer leg of 1846–1852, it remained

for the same inventor and manufacturer to surpass even his original triumph by the still more perfect limb which he has now exhibited, and which has secured the unanimous award of this Committee. The attainment of this superiority has doubtless arisen from the fact that Mr. Palmer had the misfortune to lose a leg in his early boyhood, and has given the best energies of his life and his utmost skill as a mechanician to the invention of a substitute that should, as nearly as possible, replace, in form and movement, the lost member. To secure all the required conditions is no easy problem, and has been well described as a work of combined surgical, mechanical, and artistic skill. The artificial limb must be in size, shape, and action a close counterfeit of the one whose place it supplies. It must fit the stump with accuracy and ease, and to be comfortable must be light and yet strong, flexible yet firm, and must act with certainty, promptitude, and force, yet without noise. Nothing but constant and intelligent attention to every minute detail of construction, and a long personal experience of the effect of every modification, could be expected to result in an appliance adapted to meet all the requirements of every case.

The patents of Palmer were followed by a long list of American inventions, which present little in the way of new or important principles of construction. Most of them follow the general construction and finish of the Palmer limbs, and content themselves with slight modifications in joints, springs, cords, and pulleys to effect the same purposes which had been already successfully accomplished. A glance at the limbs in the Exhibition was sufficient to show after what model they have been formed. Even the extraordinary demand created by the war did not succeed in bringing into actual use any large number of these inventions. About a dozen makers, and much less than that number of patents, seem to have divided the Government patronage, guided by the choice of the mutilated soldiers. About half the limbs furnished by the Government were of Palmer's make, and the testimony shows that they gave general satisfaction. Of the other half, many were mere colorable alterations of Palmer's model, made by persons who had been connected with or employed in his establishment.

A noticeable construction claimed as a novelty was the introduction, by Dr. Bly, into the ankle-joint of a peculiar device for allowing lateral motion at that joint, in supposed imitation of nature, and for the alleged purpose of giving increased security to the tread. This arrangement seemed to meet with some approval even in the profession, and a large number of limbs provided with it was furnished to our maimed soldiers. It was not, in our judgment, sufficiently con-

sidered by those who approved this device that, in the absence of the control of the will, guided by sensation and exercise by living muscles and tendons, the introduction of a laterally flexible joint at the ankle could only prove a source of increased insecurity. This would not for a moment be disputed if it were proposed to place such joints near the ends of crutches or canes. All the required adaptation to uneven surfaces can be safely left to elastic cushions placed under the foot of the artificial limb. These yield sufficiently to maintain a sure foothold, while they do not introduce an element of instability in the continuity of the leg itself. In most if not all of the numerous patents of Bly, the provision for lateral motion is introduced and insisted upon.

We have examined carefully all the patents for artificial limbs, granted by the United States Government. Of this large number the following are the only ones represented in the Exhibition:

Wickett & Bradley (Selpho).		Marks	2
Clement	1	Palmer	4
Condell	2	Pingree	1
Foster	2	Trees	1

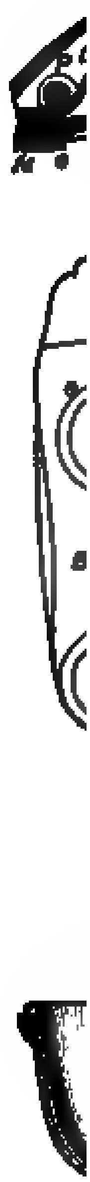
It would be unprofitable to enter into any further description of the majority of the American patents, since the alleged inventions consist, for the most part, as before intimated, of mere mechanical modifications in the details of construction and arrangement of parts, and present no new and important features marking a true advance in the art.

We except from this remark the last patent of B. Frank Palmer, dated April 8, 1873. The following description of this invention is taken from the specification of the American patent, No. 137,711, dated April 8, 1873:

"Figure 1 is a side elevation of an artificial leg having my improvements. Fig. 2 is a bottom view of the foot. Fig. 3 is a longitudinal vertical central section of the foot. Fig. 4 is a transverse vertical section of the foot through the ankle-joint. Fig. 5 is a longitudinal central vertical section of the leg. Fig. 6 is a similar section of the stump-socket. Fig. 7 is a view, partly in section, of my improved heel-cord or tendon. The same part is marked by the same letters of reference in all the figures. This invention consists in various details of improvement in the construction of the artificial leg heretofore invented and patented by me, and generally known to the public as the Palmer leg. The object of these improvements is to render the leg lighter, stronger, more elastic, and lifelike in its

motions; to adapt it to support the weight of the wearer in certain cases upon the end of the stump by the introduction of a properly-constructed socket; to give a double support to the foot in certain positions, one of which takes effect before the other, by the introduc-

Fig. 3 Fig. 4



tion of supplementary or auxiliary tendons in addition to and in aid of the cord or tendon representing the natural tendo-Achillis; to improve the movement of the toe, and to give a fine, external finish to the limb, while dispensing with the hide by which it was formerly covered. In the drawing, *A* marks the leg proper, which is made hollow, as represented. I prefer to use English willow as the material, as long experience has shown it to be so admirably adapted for the purpose. The leg is provided with ventilating openings, *d*, *d*, in

the ordinary manner. Instead of covering it with raw calfskin, as heretofore, I now dispense with that covering at a considerable saving of weight. To compensate for the loss of support resulting from the removal of the hide, I bind the top rim of the leg, the only joint where such support is required, with brass wire wrapped tightly around it and turned off smooth, forming a band, *I*, which gives all necessary strength to that part of the limb, while adding but a trifle to its weight. The enamel or finish of any kind is applied directly to the exterior surface of the leg. To the upper rim of the leg are attached the lugs *H*, forming the lower branch of the knee-joint. These are hinged at *F* to the upper member, *G*, of that joint. The part *G* is formed in one piece, bowed around the back of the thigh-socket *D*, as shown in Fig. 1. It is provided with buttons *a f*, to which the upper ends of the tendons *J*, *J*, and *T* are attached, as seen in Figs. 1 and 5. The thigh-socket *D* is made of leather, and in the ordinary way, and is adapted to the size of the thigh of the wearer. At its lower end the leg *A* is attached to the foot *B* by means of the ankle-joint *Q*. This joint constitutes one of the important improvements in the construction of the limb. In my former patent this joint consisted of two branches, which ran up the inside of the leg and were united at their lower ends by a bolt which passed through the foot. To support this bolt the foot was made solid and consequently heavy. I now make the ankle-joint in the shape of a horseshoe, as shown in Fig. 4, place it in the bottom of the foot with its ends projecting upward. Through the eyes in these ends is passed the bolt *R*, which passes through the block *S*, which forms part of, and projects down from, the leg *A*, as shown in Figs. 3 and 4. The joint *Q* is bolted or otherwise firmly attached to the foot. This construction enables me to make the foot hollow almost throughout, as shown in Figs. 3 and 5, giving it a lightness hitherto unattainable. Lightness is more important in the foot than in any other portion of an artificial leg, as whatever weight is there acts at the end of a long lever, and serves to impede freedom of movement. The toe-piece *C* is hinged to the foot at *K*, and is made with an entering-joint similar to that at the ankle, presenting no break in the surface. The toe-piece is strengthened by wires run transversely through it to prevent splitting. The toe-tendon *L* is made of two cords attached to the under cavity of the toe-piece, as shown in Fig. 5. They run around the under side of the pulley *P*, and are carried up to a point at the top and rear of the leg, where each of the cords is attached to a spiral spring, *h*. The reaction of the spring tends to draw the toe down. *K* is the main heel-cord or tendo-Achillis. It is made of parallel strands of sewing-silk covered with chamois-skin,

as represented in Fig. 7. It is fastened near the bottom of the heel by the pin, and runs up to a point in the back of the calf of the leg, where it is attached by the pin. This main tendon, upon which the greatest strain comes in using the limb, is made larger and stronger than I have heretofore made it, since it is required to be less elastic than formerly, because I now supplement its function by the addition of the two auxiliary tendons *J*, *J* placed one on either side of it, as shown in Figs. 4 and 5. The tendons *J*, *J* diverge at the heel and run up the inside of the leg, and are attached at their upper ends to the buttons *a* on the sides of the bowed joint-piece *G*. These tendons are so regulated in length as to take the strain, ordinarily thrown wholly upon the heel-cord, a little before any part of it is borne by that cord. This relieves the heel-cord, assists it in bearing the strain, and enables me to make it stronger and less elastic than heretofore, as before observed. A black cord or tendon, *T*, is attached to a button, *f*, on the rear side of the thigh-socket *D* (see Fig. 5), and is fastened to the calf of the leg by the pin. The office of this cord is to limit the motion of the knee-joint by a strong and firm yet moderately-yielding attachment in place of the rule-joint heretofore used, which was abrupt in its action, and often caused a 'click,' which was highly objectionable. One of the most important improvements, looking to the ease and naturalness of the tread and movement of the foot, is presented by the protuberances *M* and *N* placed on the bottom of the foot at the ball and heel, respectively. These are most clearly shown in Figs. 2, 3, and 5. They receive and support the weight of the wearer, and allow a lateral movement resembling that of the natural ankle, while unaccompanied by the unsteadiness which has characterized previous attempts to impart this movement into the artificial leg. Around these protuberances, after covering them with felt, I place the elastic rubber tubing *e*, arranged as in Fig. 2, and over all attach a covering of buckskin or chamois leather. This construction gives softness and elasticity to the tread, while securing the utmost freedom of movement to the foot compatible with steadiness and safety. To provide for sustaining the weight of the wearer upon the end of the stump, I receive the stump in a socket, *e*, made of leather, and made to conform accurately in length, size, and shape to the stump which rests in it. This conformity is attained by moulding the socket on a cast. I usually make the stump-socket of two thicknesses. A rim is formed at the top which rests upon an elastic cushion, *b*, formed of rubber tubing placed on the upper rim of the leg. The stump-socket is received in a recess of form corresponding with its own in the top of the leg, so that whatever elongation takes place in walking

is the result of the drawing out of the socket from the recess. The stump is not withdrawn from the socket *e*, and there is no feeling of insecurity and no want of precision in the step. The use of silk covered with chamois leather for the heel-cord is an improvement which I consider important. In my former patents I indicated a preference for the use of catgut for that cord, as I found it much the best material that I had at that time tried; but it is very liable to fray out by friction, is difficult to fasten at the ends, and is greatly affected by changes in the hygrometric condition of the atmosphere. It becomes longer or shorter according to the amount of moisture in the air, and thus introduces an element of uncertainty and insecurity in the use of the limb. Silk I have found to possess the requisite strength, flexibility, and freedom from change. The formation of the upper member of the knee-joint in one piece, bowed as described, renders the joint lighter and stronger, and prevents the lateral spreading which occurs in those made in the old way. As a covering and support I wind the leg and foot, in whole or in part, with thread. A coating of gum shellac is applied to the wood, and the thread is tensely wound into the gum. To this firm and smooth coating of thread and gum the enamel, principally of shellac, adheres immovably. This covering is not affected by water or varying temperature as a skin glued to the wood would be. Thus, with diminished weight, greater durability and an exquisite finish are obtained. What I claim as my improvements in artificial legs, and desire to secure by letters patent, is,—

"1. The double toe-cord *L*, running in the pulley *P*, and attached at the rear and back of the leg, as described and shown.

"2. The toe-piece *C*, strengthened as described, and forming a close joint with the foot as shown.

"3. The protuberances *M*, *N*, on the bottom of the foot, as, and for the purpose, described.

"4. In combination with the protuberances *M*, *N*, the elastic cushion *e*, *e*, formed of rubber tubing, and arranged substantially as, and for the purpose, stated.

"5. The ankle-joint *Q*, made of a curved or horseshoe form, as represented, and placed in the bottom of the foot, with its ends projecting upward to receive the ankle-bolt, all as, and for the purpose, described.

"6. The heel-tendon *K*, made of strands of silk covered with leather, as described.

"7. The supplemental or auxiliary tendons *J*, *J*, arranged, attached, and operating as set forth.

"8. The covering of thread and gum shellac, for the purpose set forth.

"9. The stump-socket *E*, made of leather, moulded to conform to the stump, and resting by a shoulder on an elastic cushion, about the upper rim of the leg, and fitting snugly, but so as to be easily withdrawn, in a recess of corresponding shape in the top of the leg, all constructed and arranged substantially as set forth.

"10. The bowed joint *G*, constructed, arranged, and operating as described.

"11. The confining band or hoop *I*, formed of wire wound tightly around the leg, and turned off on the surface, as, and for the purpose, specified."

The leading peculiarity of this invention is the device, appropriately called the "safety-socket," which resulted from the important discovery by Dr. Palmer that the true principle of support in an artificial limb is, in the great majority of cases, to take the weight of the bearer upon the end of the stump. Occasional instances had indeed been known in which the weight was thus borne, but they were altogether exceptional, and the idea that surgeons, patients, and manufacturers of limbs seemed to entertain in common was to relieve the end of the stump from all pressure and guard it carefully from contact with any portion of the socket of the artificial limb. Dr. Palmer, it is true, had patients supporting their weight on the end of the stump as early as 1850, but, owing to the want of a suitable apparatus, he did not approve the practice, and continued the use of the open socket down to the year 1873. Whenever the suggestion of this method of support has since been made by other inventors, it has evidently been done on theoretical grounds alone, and the only apparatus proposed was a flexible leather sack entirely unsuited to the purpose, and indeed directly calculated to endanger the safety of the stump at every step by forcing back the integuments and tending to bring the entire weight of the wearer upon the end of the bone over which they are stretched, by the elongation of the sack itself. When the sack receives the weight its form becomes that of an inverted cone, the interior apex of which is occupied by the end of the bone, while the soft tissues, which in their natural position surround and cover the bone, are pushed back into the base of the cone. Such an apparatus, far from advancing the establishment of the principle of end support, was calculated to postpone it indefinitely by proving that method to be dangerous if not impracticable. The safety-socket of Palmer, on the contrary, is a box of double leather made to fit the end of the stump exactly by moulding on a cast, and is so held and guided in the interior of the shell of the artificial leg that it is incapable of

changing its form by the changing weight to which it is subjected in walking. It changes its position slightly by slipping up and down in the outer shell, but it keeps its place securely on the stump, and does not allow the integuments of the latter to be subjected to any change of strain, or any change of place, by reason of the movements of the leg in walking. Thus it acts as a shield and protector for the stump, guarding it against shocks by the air-cushion on which the edge of the socket is supported, and by keeping the relation between the bone and the soft parts uniform, promoting the health and development of the muscles of the stump, and preserving the cicatrice from injury or rupture.

This safety-socket is now in use by a large number of patients, whose testimony is uniform that it can be worn even on a short and tender stump, taking the weight on the end not only without inconvenience or pain, but with a new sense of comfort and security. Many of the wearers were before us in person, and the testimony of many others was submitted, leaving no room for doubt as to the great superiority of this apparatus. The wearers describe it as being perfectly comfortable, as affording greater control over the artificial limb, and giving to the end of the stump a sensation much resembling that felt on the heel and bottom of the natural foot, and relieving, in a great degree, the nervous sensitiveness which is usually so great a cause of suffering to the amputated.

TRUSSES.

The selection of an artificial limb is a matter of great importance to the individual who may be so unfortunate as to require its assistance, but its relative importance, when compared with the selection of a truss, sinks into insignificance. Whichever limb may be selected from the many manufactured, however poor its construction and imperfect its mechanical arrangement, it will possess some merit, and be of more or less assistance to the wearer. It is not so with a truss. If it is not constructed upon scientific principles, well fitted and adapted to each individual case, the suffering of the wearer is increased, and, in many instances, life is jeopardized.

The great importance of these instruments may be realized when we reflect that no age, sex, or condition is exempt from the accident of rupture, and that one person in every ten suffers from this calamity. Among the laboring classes the average is nearly one in six.

Requirements of a Truss.—The requisite and essential qualities of a truss are lightness, firmness, and elasticity, so that it shall retain

the required form or shape, suitable adaptation to the configuration of the wearer, and sufficient strength of spring to prevent the escape of the rupture from the abdomen. The instrument consists of a pad, or cushion, attached to a metallic spring with straps, so arranged that its movement during the varied postures of the body may be restrained. The circular spring truss is the most suitable form in the majority of cases. Bandages which are not elastic do not afford sufficient support to the hernia in every position of the body. They are necessarily unsafe on this account, as they become lax in the stooping posture of the wearer,—the position of all others in which the hernia most easily descends, because of the relaxation of the pillars of the external ring. The curve of the opening and the relative position of the pad with it should be appropriate to the configuration of the wearer. A single piece of metal should form the spring and foundation of the pad. As far as practicable, the spring of the truss should pass around the bony rim of the pelvis, fitting closely to the figure, and should lie out of the region of the gluteal muscles; for, unless it is so placed, their alternate action in progression produces a corresponding movement of the pad. If these muscles be largely developed, extending upwards to the very edge of the pelvis, the curve of the spring should be wide at the shoulder, so that its bearing or resting part should be on the base of the sacrum. For a single-pad truss the free end of the metal spring should be beaten out flat and thin, and so ground as to cling around the opposite hip,—an arrangement which materially aids in steadying the truss. The form of the spring may be designed after the French or German pattern. The former resembles the coil of a watch-spring, and is very elastic and clinging; the latter almost exactly fits the outline of the body in its state of repose, is inelastic, and very hard. The French is always pressing inwards when the wearer is at rest. The German scarcely presses at all when the abdomen is soft, but resists with power when any expulsive force makes the abdomen swell. In practice the best shape for the spring is one which forms a medium between the two. The pad, or cushion, should be of moderate dimensions. For the adult it should not exceed two and a half inches in length, and two inches at the widest part; its superior edge should follow the upper line of the spring, which falls a little from the shoulder or bend, where it lies in contact with the hip. The inner surface should be directed slightly upwards, but this inclination must depend upon the prominence, or otherwise, of the abdomen, as well as, in some measure, on the anatomical relations of the pelvis to the spine.

The proper shape of the cushion, or pad, and the material of which

it should be constructed, may be varied to accommodate particular cases, or to accord with the views of the different inventors. Generally, the wearer discovers, after a little experience, which kind of pad is most free from annoyance. That pad, however, is the best which maintains perfect and unintermitting retention of the hernia. Every pad should have attached to it two studs, one near its junction with the spring, and another at its lowest point. To the upper one the transverse strap passing from the free end of the spring is attached. The lower stud is used with the thigh-strap, which should always be worn. It is loosely fastened on the spring of the truss, near its shoulder, and should fall along the hollow beneath the buttock. In the erect posture of the wearer this strap should be moderately tight. It prevents the pad from slipping from its proper position, and should never be discarded.*

The principal advance in the manufacture of trusses, in regard to construction and finish as well as material, has been made within the last twenty years. The old clumsy instruments, made after the Hull pattern, have given place to inventions combining extraordinary lightness and efficiency with comparative cheapness. The substitution of the wooden, ivory, and rubber block for the soft pads, formerly in vogue, marks one of the most valuable additions to the mechanical surgery of the present century. With the old instruments the hernia was imperfectly retained, and a radical cure never effected; with the improved American truss the hernia is perfectly secured, and, in favorable cases, a radical cure is frequently effected.

Of the ninety-four truss-manufacturers in the United States, but thirteen were represented at the Centennial Exhibition, but these embraced all the leading manufacturers, and comprised every truss of recognized merit. Some exhibitors submitted from five to twenty different patterns, modifications of, and improvements upon, leading patents, most of which have expired. Others exhibited only their own inventions. Of the thirteen exhibitors in this specialty, six are deserving of special notice, not only for the magnitude of their display, but for the perfection of construction and beautiful finish of all the instruments they submitted for examination.

W. Horn & Bro. exhibited a large and choice selection of trusses of the most approved patterns. They were all simple in construction and well finished, each and every part giving evidence of unusual care in the manufacture. The distinguishing specialty of this firm is the manufacture of the truss spring, a branch of the business requiring

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* Holmes.

the utmost nicety in the selection of the material to be used, and great skill in securing the requisite temper. The springs manufactured by Messrs. Horn & Bro. were carefully tested by the Judges, and found to be fully equal to every requirement, and were, certainly, the best exhibited.

The largest assortment of leather-covered trusses was exhibited by Penfield & Co., of Philadelphia. It embraced over thirty different patterns, including Penfield's set-screw, or common-sense truss, Chase's, Phelps', Foster's, and Thompson's original designs and modi-

Chase.

Foster.

fications, as well as a large assortment of French and German patterns, the peculiar features of which have been referred to previously. It would be a difficult task to select any one of those exhibited by these manufacturers as being superior to the others. All were intrinsically good in every respect, only differing in design and the mechanical means employed to secure the desired end. In leather-work they were not excelled. In addition to those covered with leather, this firm presented for competition a large assortment of trusses covered with celluloid. This is a composition which was at first made from

gun-cotton and camphor, but recently white paper pulp has been substituted for the gun-cotton. The material formed by this combination resembles ivory so closely as to deceive, unless critically examined, and when properly colored may be readily mistaken for coral. It is extremely hard, tough, and elastic.

The celluloid truss, in mechanical design and construction, is exactly the same as Penfield's set-screw or common-sense truss, but instead of covering the spring with leather it is covered with celluloid, and the pad is made of the same material pressed into moulds, forming hollow shells. They are light, cleanly, and durable. Celluloid is used very largely in the manufacture of toilet articles, such as hair-brushes, combs, etc.; it is spoken of highly, by S. S. White, as a pleasant substitute for hard rubber in the manufacture of artificial dentures; it is also used very extensively in the manufacture of jewelry as an imitation of coral. It is manufactured in large blocks, and when exposed to the requisite heat becomes soft, pliable, and is readily moulded into any form. The manufacturer has availed himself of these qualities, and adapted the material to the covering of the spring, instead of using leather. It makes a remarkably handsome instrument, which, it is claimed, can be worn while bathing, and is exceedingly durable.

Penfield's celluloid truss, set-screw, and lever.

The annexed cut represents the complete truss. The set-screw secures the pad in any desired position, and, by means of a lever operated by the screw, any desired amount of pressure can be obtained. Perhaps no invention, or special adaptation of an invention, has met with more decided opposition by the trade than this, which is partly owing to the fact that trusses were coated with this material before the invention had been fully matured, and the composition of the material sufficiently tested to insure its durability, freedom from shrinkage, etc. The patentees claim that there has been a decided improvement made, by the substitution of white paper pulp for

gun-cotton, and that it will not contract or crack by age or exposure. The principal and, I think, now the only valid objection, which can be substantiated, is its highly inflammable nature. When brought into contact with a flame, it burns with fierceness and great rapidity. If this decidedly objectionable feature can be overcome, it will prove to be one of the most valuable discoveries of modern science, fully equal to the famous discovery of Goodyear, "hard rubber."

The Elastic Truss Company of New York exhibited a large collection of trusses made entirely of elastic silk webbing, no spring being used in the construction. The annexed cut represents the truss as exhibited. There were a number of imitations of this article exhibited by other manufacturers, but they were all of less merit than the original invention, and necessarily received no notice from the Judges.

The beautiful display made by J. B. Seeley, of what is known in the trade as the "hard-rubber truss," deservedly attracted marked attention; not on account of any peculiarity in design (for he in common with other celebrated manufacturers has adopted those patterns which are most in demand by the profession, as the Foster and Chase models), but from the material used in their construction. The application of hard rubber as a covering for the steel spring, and in the construction of the pad, marked a new era in the manufacture of trusses, and conferred an inestimable boon upon the unfortunate sufferers who are compelled to seek these artificial supports.

The method adopted by the manufacturer is to prepare the spring in the same manner as if it were to be covered with leather; the hard rubber is then vulcanized on the spring, and so perfect is its adhesion to the steel that it is impossible to remove any portion without detaching flakes of the metal, with which it appears to be intimately incorporated. The spring being perfectly protected from moisture, cannot rust, and hence retains its strength and elasticity for many

years unimpaired. The pad being made of the same material, always presents a dry, polished surface to the skin, thus avoiding the irritation, chafing, and blistering which so generally occur when the pad is made of material which absorbs moisture or is affected by perspiration. In durability, cleanliness, efficiency, and perfection of construction in all its minutiæ, this truss had no equal on exhibition. The annexed cuts represent the most desirable patterns exhibited by this manufacturer.

Fig. 1 is best adapted for general cases of single hernia; it will admit of the adjustment of any one of the pads shown in the cut.


FIG. 1.


No. 3*a*. No. 3*c*. No. 8. No. 4. No. 1.

As represented, the No. 3 pad is used. The No. 1 pad is grooved or corrugated, and is suitable for light cases; it covers the upper and lower rings and avoids direct pressure on the spermatic vessels. No. 3 *a* is a small plain convex pad, used only in cases of femoral hernia. No. 8 is plain and convex, with ball-and-socket action; it has a set-screw, which enables the surgeon to set the pad at any given angle or desired position. This truss is the English or cross pattern, and is applied from the side of rupture.

Fig. 2 shows the Chase model adapted to the hard-rubber pad; it is a pattern which meets with much favor in the profession.

FIG. 2.

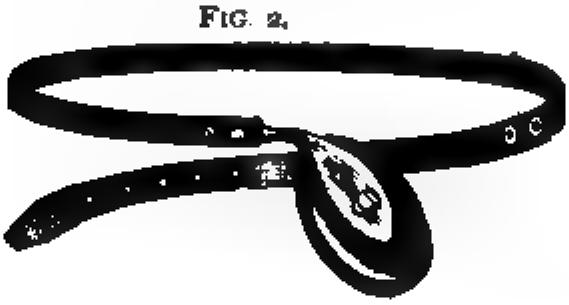


FIG. 3.

Fig. 3 is the same pattern of truss as Fig. 1, but Seeley's combination pad has been adjusted to the spring. It consists of a hard-rubber oval ring upon which rests an elastic cushion of the same shape; the centre is occupied by a hard-rubber ball. The oval ring is attached to the body-spring by a gold-plated arm; the ball is secured

to a fine steel spring, which is fastened by a button-head adjusting-screw to the metallic arm and end of the body-spring. *A* shows the front view of the pad. *B* shows the oval ball and ring with the cushion removed. *C* shows the elastic cushion, which can be removed when soiled. This truss is especially applicable in cases where it is difficult to retain the rupture, as in omental hernia, or in cases which will justify an attempt at radical cure.

GALVANO-CAUSTIC BATTERIES.

Various and repeated attempts have been made during the last few years to produce a thoroughly reliable and efficient galvano-caustic battery for the use of surgeons. Until quite recently those presented to the profession have been large and costly. With the diminution of size, to meet the essential requirement of portability, there has been a proportionate diminution of power and uncertainty of action, which, combined with many other practical objections, has rendered them almost worthless for any protracted surgical operation. To Dr. John Byrne, of Brooklyn, New York, the medical profession is indebted for the first battery for galvano-caustic surgery that combined the essential requisites of portability, power, and comparative inexpensiveness. The battery manufactured under his direction was superior in all respects to any heretofore made on either side of the Atlantic, and was, for a long time, looked upon by the profession as the final solution of a much-vexed question. Practically, however, there are several objections to it: the carbon plates are necessarily thin, and hence very brittle; polarization of the battery is of frequent occurrence, so that when used by one less expert than the inventor, one has serious misgivings that the operation may have to be suspended on account of deficient power in the electrodes.

A battery exhibited by Kidder was submitted to a severe test, a continuous white heat being kept up for several minutes; the heat was sufficiently intense to melt the small electrodes and fine platinum wire. Its only apparent fault lay in its being too large to be readily carried around. For hospital work it was all that could be desired.

The most complete battery presented for competition, was one exhibited by Tiemann & Co., invented by Dr. Dawson. It is very portable, measuring only 8½ by 4½ inches. It is a great improvement on Dr. Byrne's, being more powerful, more reliable, and not likely to get out of order. Its construction differs from that of Byrne's in the substitution of platinum for the negative plates, in lieu of carbon.

This substance has long been known as unequaled as a material

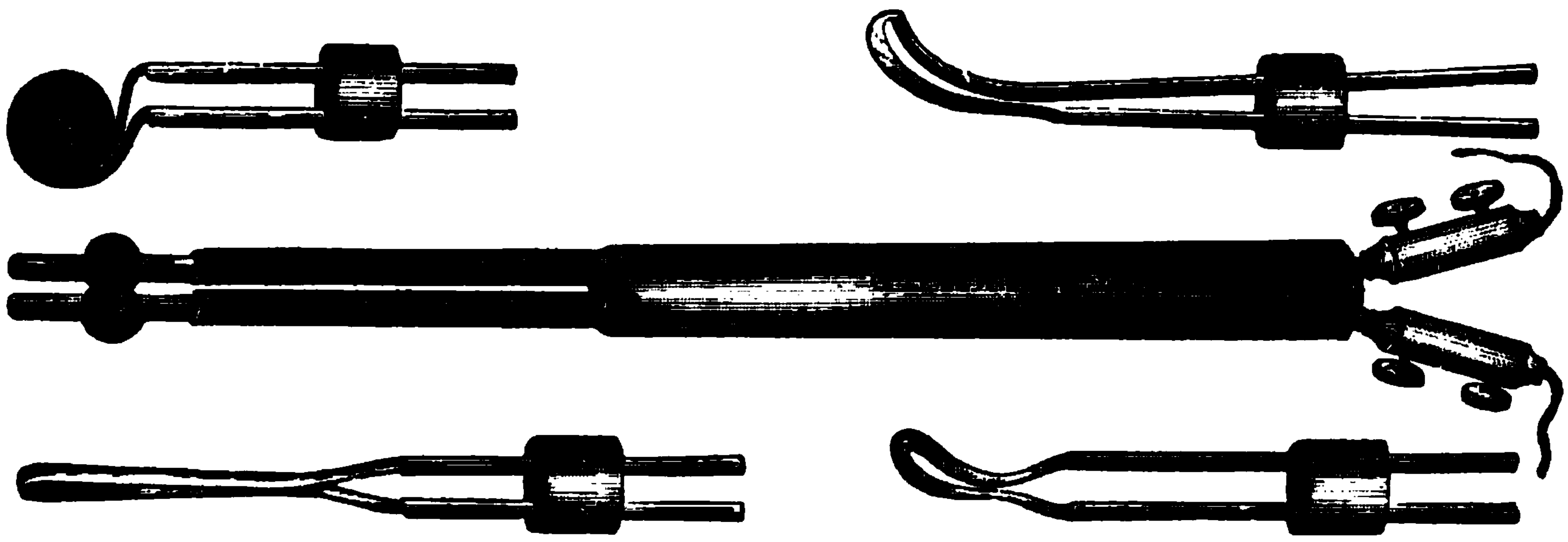
for the negative plates of galvanic batteries, excepting that, if used over a certain thickness, it increased the expense of the batteries too much to make them available to the mass of the profession, and, if used too thin (as foil), it had the objection of heating when the battery is in action, thus causing the fluid to become hot and even to boil after a few minutes' action, an objection too great to allow of its use. This heating of the platinum plates Dr. Dawson has succeeded in almost wholly overcoming, by the simple device of bordering thin platinum with pure lead, the latter being cast upon the edges of the plates by means of a mould. By this device the electric current is largely taken up on all sides of the platinum, and thus the latter is relieved of the accumulating current and the heating avoided. Polarization of the battery he obviates by the simple arrangement of perforating the zinc plates and placing agitators between the latter and the platinum plates, by the occasional moving of which the hydrogen bubbles and sesquioxide of chromium are displaced and the exhausted fluid between the plates removed; fresh acid enters through the perforations in the zincs, the outside surfaces of which are protected by an acid-proof covering.

Agitators or Pumps.

The accompanying illustration shows the principle of construction

and represents a two-cell battery. The cells are made of hard rubber and contain each two positive (zinc) and one negative (platinum) plates, each measuring $4\frac{1}{2}$ by 6 inches. The space between the zincs is $\frac{7}{16}$ of an inch. *A* represents the zincs and perforations; *B*, the lead bordering of the platinum plates; *C*, the knob, or handle, to lift and depress agitators; *D* and *E* are the connecting screws for conductors.

The annexed cuts show the electrodes which accompany the bat-



Galvano-cautery Electrodes.

tery. They are strong, and adapted for almost any surgical operation in which the galvano-caustic knife would be selected.

RAW-HIDE ORTHOPEDIC APPLIANCES.

S. A. Darrach exhibited a series of valuable and ingenious contrivances for the treatment of every variety of deformity, but more particularly designed for use in cases of spinal curvature and hip-joint disease. The body of the instruments is manufactured of raw-hide, which, when properly prepared, can be moulded to any shape, and will retain the particular form given. It is light, elastic, and substantial, and can be made sufficiently strong to resist any necessary strain. As a base for the attachment of braces to be applied to the limbs or body, it has no equal. In the treatment of hip-joint disease, or when counter-extension is necessary during treatment of fractures of the lower extremity, the use of this apparatus avoids the necessity for the perineal band.

Fig. 1 represents one of these supports applied to an ordinary case of lateral curvature. The corset is cut, partly separating the section which embraces the projection. A lever connects with this part, having a fulcrum attached at the base of the corset, and is so arranged that the movement of a screw produces three directions of pressure opposed to the position of the deformity. On each side of the corset are attached elastic adjustable crutches which embrace and

support the arms; the counter-extension is supported by a well-diffused bracing over the lower part of the back, assisted by strong

Fig. 1. Fig. 2.

elastic bands or extensions of the lower and anterior portion of the corset. Elastic cushions are attached inside those portions of the anterior extension which rest upon the crest of the ilium. Various attachments are applied to the corset, when needed to increase the rigidity of any special part.

Fig. 2 shows an attachment to support the head and regulate the elevating tension when the disease is located in the cervical region; it controls the position of the head, permitting a proper degree and direction of motion, at the same time relieving the vertebræ from pressure. A modification of this instrument was exhibited, which was specially designed for the treatment of wry neck. It is simple and efficient, being a very decided improvement upon any hitherto used.

Fig. 3 shows an appliance designed for the forcible extension of the limb in cases of contraction of the knee-joint. The clasps which fit the limb above and below the knee-joint are, like the corset, made of raw-hide. The upper and lower portions are connected at the sides by steel bars, with a suitable joint at the knee. At the back of the upper clasp is a steel plate to which is attached a tube; in this tube a rod telescopes. The lower end of this rod is connected with a stud which slides on a rack attached to the lower clasp. On the

rod is a spiral spring, one end of which rests against the stud, the other against the tube. The stud is moved by a pinion-key, and

FIG. 3.

FIG 4.

fastens with a self-acting catch. When the stud is moved upwards, it causes extension, the spring being compressed in proportion to the resistance. When walking, the spring can be arranged to permit partial motion at the knee-joint, or it can be locked, and thus prevent motion. When necessary to produce extension to relieve pressure at the knee-joint, the instrument can be attached to the shoe, and extension made from the thigh, by changing the side-bars.

A very complete apparatus was exhibited for the treatment of hip-joint disease. It is a modification of Fig. 3 combined with the corset; it is designed to remove all pressure from the hip-joint, and, if necessary, retain the limb in a fixed position.

The inventor has placed at the disposal of the surgeon a series of mechanical contrivances of great practical value, by the use of which these distressing diseases can be more easily and successfully treated.

. Darrach's wheel-crutch, represented in Fig. 4, is a light, graceful, and substantial frame, made with iron pipe and steel rods, open at the back, and mounted on light metal wheels, the rims of which are covered with sole-leather to prevent noise. The various parts are capable of adjustment to accommodate differences in height and length of limbs. The inventor gave an exhibition of patients undergoing treatment for paralysis of the lower extremities, hip-joint dis-

ease, and other ailments which preclude the possibility of unassisted locomotion, who could and did travel in every direction with considerable rapidity and ease when using these crutches.

SPLINTS.

Several years since Mr. G. Day, of Hayden, Vermont, offered to the profession a complete set of splints carved out of soft wood, and suitable for every variety of fracture; simple in their construction, easily adapted, and of moderate price. They were very favorably received by the profession in this country, and obtained, and still have, a large sale. The exhibit made by this manufacturer was highly creditable, and very justly received a recommendation for an award as marking a decided advance in this branch of prothesis. For some time these splints were the only ones relied on in hospital- and field-practice. The introduction of Ahl's invention, however, has generally superseded them.

Ahl's Adaptable Porous Splints are made of felt saturated with gums, which are insoluble in water. While soft, they are moulded on blocks which have been cast from a series of models of various sizes taken from the limbs of soldiers of the United States army. Their principal advantages are:

1. By dipping them in hot water they can be moulded to every inequality of the limb, rendering padding unnecessary, even in the most complicated cases.

2. Their shape and firmness being unaffected by cold water or heat under 150° Fah., cold water can be freely applied to the limb without disturbing the adjustment of the splint.

3. Being porous, the limb can be completely incased with the material, and yet kept cool, there being abundant opportunities for evaporation.

4. The adaptation of the splint to every part of the limb being perfect, a fracture, when well adjusted, can be transported any distance without disturbing the fractured limb, or incommoding the patient, a most important consideration in field-practice.

5. Their cheapness, compactness, simplicity, firmness, combined with lightness and almost indestructibility.

The Judges examined these splints with great care and interest, testing them to their complete satisfaction, and were unanimous in the opinion that they supply a necessity in the treatment of fracture, deformities, and the diseases of the joints which has long been felt,

but never before filled, and mark decided progress in this important branch of prothesis.

Wood's Hammock Splint is an apparatus so constructed as to be adaptable to any kind of fracture of the leg or thigh, either on the right or left side, and adjustable to any length or size of limb. It consists of a light substantial frame-work, readily adjustable in all directions, supporting an internal and external rod, corresponding to the long and short splint of Desault and Physick. On the outside of these rods are closely-set hooks for the attachment of the hammock-cloth in which the fractured limb is to be suspended. Fig. 1 represents the features of the splint closely; *A, A* are the rods referred to;

FIG. 1.

Wood's Hammock Splint.

at 4 is shown a double clamp and ratchet combination by which the apparatus may be readily and securely adjusted in any desired position, from the straight line to the right-angled double-inclined plane.

The attachments for extension are ordinarily made to the limb by adhesive plaster. Tapes thus secured to the limbs are carried to the crossbars and made fast at *O*, *O*, Fig. 1, the bar having been previously pushed back against the coiled wire springs *e*, *e*. These springs, by forcing the crossbar forward, carry the distal fragment with it, thus slowly but persistently exerting an extending force, that lessens as the desired result is nearer attainment. The foot-piece is movable in all directions, and may be securely fastened at any point. It is only used to secure the position of the foot, extension being effected from the crossbar only.

Fig. 2 shows the apparatus applied to the right leg, as for fracture of the thigh, the straight position being selected. It will be observed

FIG. 2.

that the hammock extends smoothly from heel to waist, and that the anatomical formation assists in securing some counter-extension from the nates. The upper part of the hammock-cloth is cut to clear the anus, and then carried round the body to be attached to the hooks on the outside rod. Being unbandaged, the limb is exposed on its anterior surface, and can be readily examined in any other part without disturbing either extension or counter-extension, by unhooking the hammock-cloth at the desired point, and cutting it so as to form a tail, as shown in Fig. 3. The cut piece is to be refastened to the hooks when the examination is completed. Small slits cut in the hammock-cloth permit continuous drainage in cases of compound injuries, a small vessel being placed beneath the opening to receive the fluids. The free use of water, medicated or otherwise, will be facilitated by the use of the movable siphon irrigator, Fig. 1, *K*.

FIG. 3.

Although somewhat complicated, the apparatus is little liable to derangement in the hands of an accomplished surgeon. Taken as a

whole, it is unqualifiedly the most perfect instrument yet designed. Its principal points of excellence are: 1. Its readiness for immediate use; 2. Its ready adaptability for every conceivable fracture of the lower limbs, and for every size and length of limb, one splint being all that the surgeon requires; 3. The facility afforded for the examination of every part of the limb without disturbing it, or interfering with the union of the fractured part; 4. The perfection of the arrangement for securing any desired extension, or counter-extension, without inconvenience to the patient.

SURGICAL INSTRUMENTS AND APPLIANCES.

Among the most interesting of the exhibits at the Exhibitions of Paris in 1867 and Vienna in 1873, were surgical instruments and appliances. But although the majority of the European nations furnished samples of this branch of industry, not one of those who exhibited in 1867 could dispute with France the palm for variety, number, and finished workmanship of the instruments.

At the Champs de Mars, however, England, whose surgical instruments have always enjoyed the highest reputation, was not represented by a single collection.

The same cause which operated to keep foreign exhibitors in this line of goods from competing at our Centennial Exhibition undoubtedly restrained English manufacturers from sending their products to France, viz., excessive duty. It would be manifest folly for any country to attempt to compete with a nation where the import duty upon the articles exhibited amounted to prohibition; no substantial gain could be expected, even if superiority were admitted.

At the World's Exhibition in London, in 1851, England fully sustained her reputation. In 1867, in Paris, the French manufacturers were unrivaled. In 1873, at the Vienna Exposition, the Germans led the van. In 1876, the American display of surgical instruments demonstrated beyond peradventure that in design, material, and perfection of workmanship American products were fully equal to the choicest samples selected from the best houses in Europe.

The exhibition of surgical instruments, both general and special, was in reality an American display. With the exception of one exhibit from Russia, one from England, and one from Italy, there was no competition.

The exhibit from Russia was from the manufactory of the Ministry of War of Russia. The collection was large and complete, and was

mainly confined to selections required for army service. The instruments were well finished, and appeared to have been made after the latest American and French patterns.

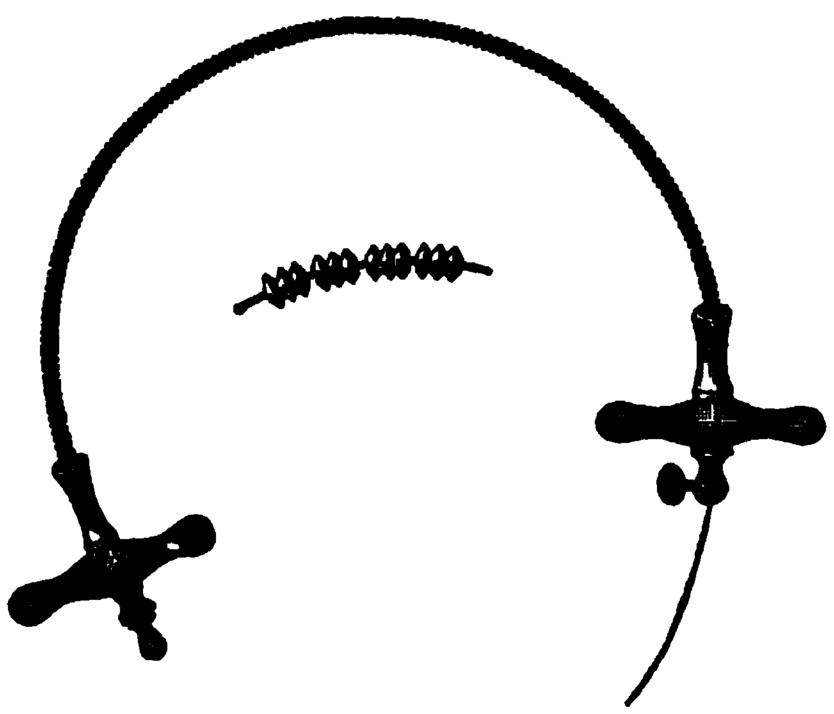
The largest collection of instruments was exhibited by Messrs. Tiemann & Co., of New York. It embraced almost every instrument used by the surgeon in general or special practice, and some few entirely new, simple, but valuable, the manufacture of which is confined to their house.

In material, workmanship, and exquisite finish they could not be excelled; they were complete in the minute detail so essential to the formation of a perfect instrument, and gave evidence of scrupulous care and a nice appreciation of the wants of the surgeon.

Most of the steel instruments were nickel-plated, which is a great improvement, preventing rust and enabling the operator to keep his instruments clean with comparatively little care.

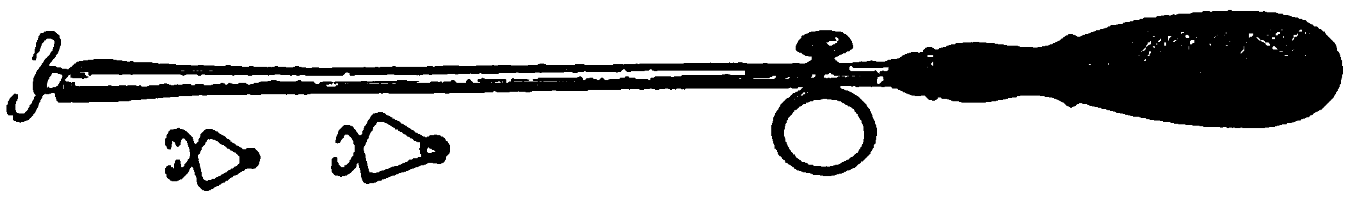
Among the novelties was an improvement upon the old "chain-saw," in which all the objections to that useful but treacherous instrument have been overcome. Who has not experienced the annoyance, in the middle of an operation, of the saw breaking, or becoming wedged in the bone so tightly as to be disengaged with difficulty? By a very simple device these objections have been overcome. Fig. 1 shows the substitute, made of steel beads serrated and strung on a strong wire. The little instrument works smoothly, rapidly, and efficiently. The automatic suture (Fig. 2) is useful in enabling the surgeon to approximate the edges of wounds upon which it would

FIG. 1.



Bead saw.

FIG. 2.



Automatic suture.

be difficult to use the needle; the serrefin is compressed and placed in the holder, pressed into position, and by pushing the ring near the handle forward the metal suture is liberated.

Fig. 3, A and B, represents an instrument devised for the removal of foreign bodies from the œsophagus. Fig. 3, B, shows the instru-

FIG. 3, A.

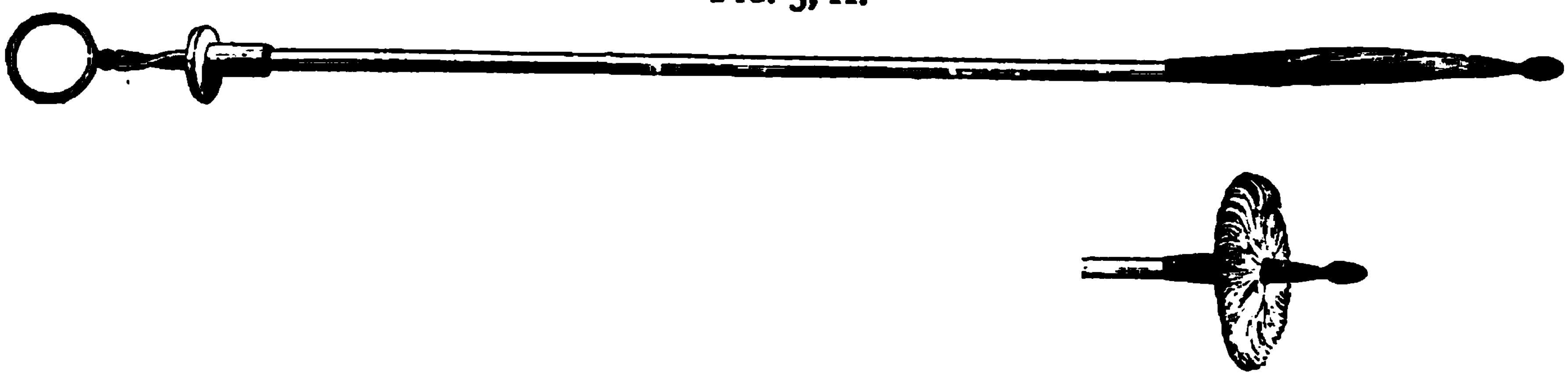
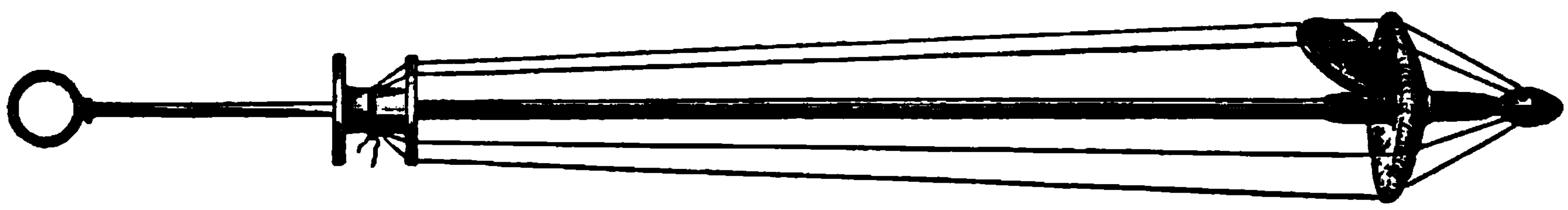


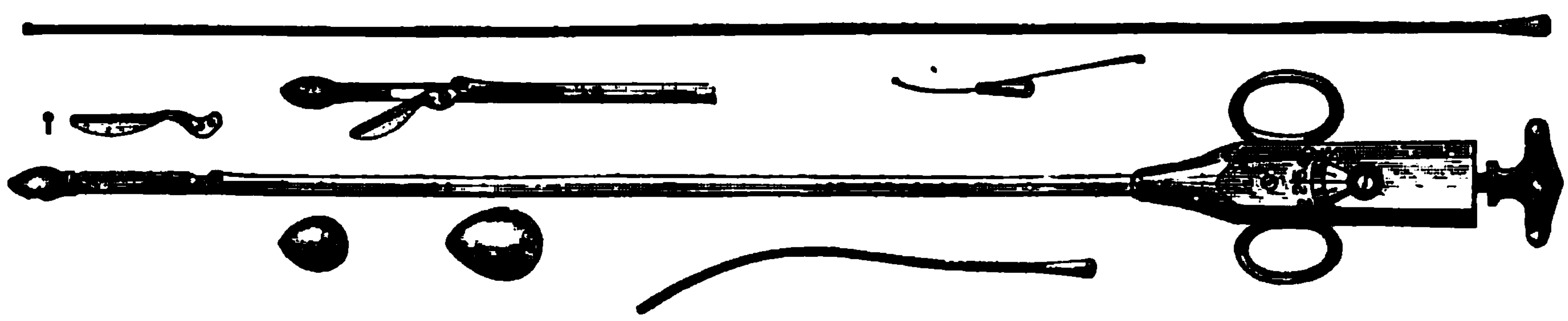
FIG. 3, B.



ment opened with the foreign body caught in the bristle disk; the handle is of whalebone.

Kinlack's new stricture-cutter will be appreciated by all surgeons who specially interest themselves in diseases of the genito-urinary system. The annexed cut (Fig. 4) explains itself.

FIG. 4.



There were many other instruments entirely new in design, among them an elastic metal catheter without eyes. The base of the catheter is a hollow silver tube; this continues for about four inches; the

FIG. 5.

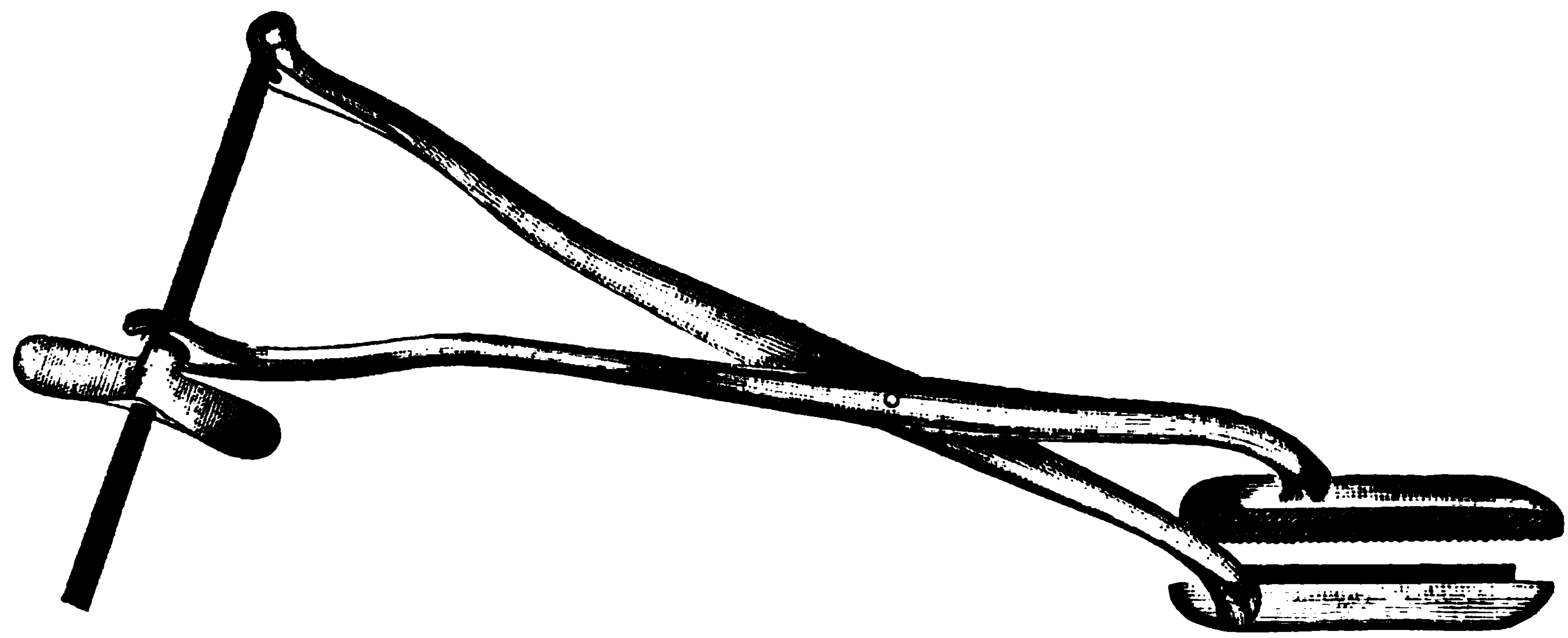
Flexible metal catheter.

metal is then twisted spirally, diminishing gradually until it terminates in a point not more than the thirty-second of an inch in diameter; through the centre a strong wire is passed, the point terminating in a

small steel bend, which is riveted to the wire. When the instrument is to be introduced the wire is drawn tight, bringing the bend up to the point and protecting the membranes as the catheter passes through. After the bladder has been entered the wire is pushed forward, and the urine can flow freely through every portion of the spiral tube. It is so extremely flexible that it will pass readily through a narrow, tortuous canal that would be impervious to the ordinary flexible catheter.

Nott's rectilinear écraseur (Fig. 6) is the best instrument yet devised for the removal of hemorrhoids. By its use the operation is rapid and

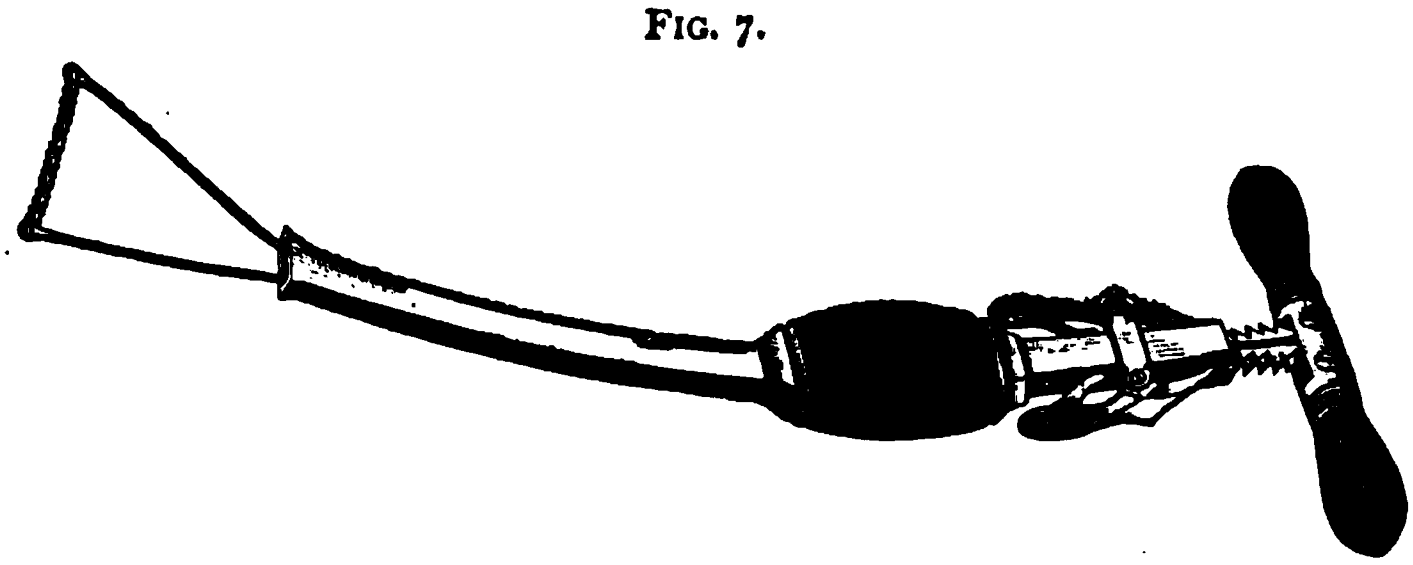
FIG. 6.



bloodless; it is also recommended for division of the pedicle of ovarian tumors.

J. H. Thompson's écraseur (Fig. 7) is designed for the rapid removal of uterine polypoid growths. It enables the operator to pass

FIG. 7.



the chain around the tumor with the greatest ease, the steel springs accompanying the chain keeping it taut until the tumor has been completely encircled.

A few instruments for operations upon the eye were to be seen in the departments of Italy and Japan, but they were of coarse finish, heavy, and unfit for delicate operations. All the instruments of real value for ophthalmic and otological purposes were exhibited by Americans. The display was of the most complete and perfect kind. All manner and styles of delicate instruments for operating upon the eye and ear were exhibited in large numbers. Particularly fine and worthy of special mention were the collections of Messrs. J. H. Gemrig and D. W. Kolbe, of Philadelphia, and Tiemann & Co., of New York.

It would be impossible to describe in the space allotted to this report the great advancement in this special branch of surgery that has occurred during the past century. On looking at it in the light of the present stand-point, it might truly be said that our forefathers knew little or nothing about the treatment of affections of these delicate organs. It would also be impossible as well as superfluous to attempt the description of the many new instruments, with their uses, that have been invented by the host of industrious and ingenious surgeons. Suffice it to say that great strides have been made towards the amelioration of the distress caused by diseases of the eye and ear.

After a careful examination, the special award for eye instruments was given to J. H. Gemrig, not only for his splendid display in this line, but for the fineness and delicacy of finish and perfect balance of his instruments. The case of ear instruments exhibited by him deserves especial mention for its completeness and perfection of arrangement. Everything he offered for inspection gave evidence of conscientious care and jealous regard for his national reputation.

D. W. Kolbe, in addition to a fine display of general and special instruments, was peculiarly fortunate in his exhibit of orthopedic appliances, which embraced every approved design for the relief of spinal curvatures, deformed limbs, etc.

Codman & Shurtleff, of Boston, made a creditable display of general instruments and dental furniture. Their improved inhaler is a valuable instrument, and received the recommendation for an award. The finest displays of dental forceps were made by Horatio G. Kern and Jacob T. Teufel, of Philadelphia; that made by the last-named manufacturer being the most extensive and elaborate. Both, however, were equally perfect in what they exhibited, and both received awards.

In the exhibition of artificial eyes, there was one in the German department from the manufactory of Ludwig Müller, represented in the United States by Dr. Theodore Roth, of Philadelphia; one in the Austrian department by F. A. Müller, whose agent here is Mr. Waldstein. James T. Davis, of New York, also entered into competition.

The display of Ludwig Müller was remarkably full and fine. The eyes were considered the finest in shape and finish and most natural in color of all the exhibits, for which he received the award. Those of Davis were very good in finish, but lacked the beauty of shape and natural coloring of L. Müller's. F. A. Müller had an ingenious exhibit of some of the diseases and appearances of the eye after operations. They were blown in glass, were very interesting and instructive. For this display an award was granted.

It is really astonishing to see to what perfection this branch of industry has been brought. Every variety of shades and points of color in the iris was depicted, as perfect and as beautiful as in nature. Müller's were particularly noticeable in this point, as well as in a peculiar arrangement of the pupil, which appeared to dilate and contract on movements of the eye in the rays of light.

In the examination of all instruments required in ophthalmic surgery the Judges were assisted by the advice and counsel of Dr. P. D. Keyser, the oculist, of Philadelphia, who was appointed by the United States Centennial Commission as a special expert on the unanimous request of the Judges of Group XXIV., and whose extensive experience at home and abroad pre-eminently fitted him for that duty.

PHARMACEUTICAL PREPARATIONS.

The display of pharmaceutical preparations, drugs, and chemicals was large and interesting, and was of itself a treatise on the immense advance made in medicine during the last century.

The magnificent exhibits of Powers & Weightman and Rosengarten & Sons attracted general admiration, not only from the profession, but from the general visitor. None but a manufacturing chemist had ever before seen such immense masses of the salts of quinia and morphia: thousands of ounces massed in pyramids, flanked by a gorgeous display of the salts of iron, whose glittering crystals of every shade and hue made the whole look like a fairy scene. Particularly fine was the large display of the sulphate of cinchonidia, one of the cheap salts of cinchona, which, through the efforts of Powers & Weightman, is now being largely and successfully used throughout the United States as a substitute for the sulphate of quinia.

Competition in sugar-coated pills was close and warmly contested. The finest displays, and unqualifiedly the best-made pills, were those of W. R. Warner and Bullock & Crenshaw. The priority belonged to Warner, who claims to have manufactured pills for Bullock & Crenshaw for some years before they manufactured for themselves.

In compressed pills, which should be made without any excipient, the contestants were Wyeth & Bro. and Dunton. Dunton's pills were excellent, and upon examination were found to be exactly what he claimed for them, but the Wyeth Brothers proved to the satisfaction of the Judges that they had the prior right as to date of manufacture.

The finest medicinal elixirs were exhibited by Wyeth & Bro. and Fred. Brown, of Philadelphia, to each of whom an award was given for the general beauty and reliability of all the preparations they exhibited.

The *pharmacopœia elegans* of Parisian pharmaceutists was well represented, and that nation earned and received full credit for beautiful display. It would be useless to enumerate all the articles exhibited; suffice it to say the materia medica of nations was exhausted: articles crude and manufactured, simple and compound, in endless variety and in the greatest profusion, met the gaze whichever way you turned; probably no previous Exhibition has ever received within its walls such a varied and valuable collection of exhibits belonging to this class.

REPORTS ON AWARDS.

GROUP XXIV.

1. McKisson & Robbins, New York, N. Y., U. S.

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for a beautiful and instructive collection of medicinal roots and barks; also for the general excellence of all the pharmaceutical preparations exhibited by this firm.

2. John Wyeth & Brother, Philadelphia, Pa., U. S.

PHARMACEUTICAL PREPARATIONS.

Report.—In order to satisfactorily test the value of the above articles, and ascertain if they contained the quantity of drugs as stated on their labels, samples were obtained and a number of experiments and assays were made; the results in some instances varying slightly, which may have been caused by the difficulty in separating the active agents from their combinations, evidently consisting of sugar, alcohol, aromatics, salts of iron, etc.

The following is a tabulated statement of the principal preparations assayed, which will show a remarkable accuracy in their preparation, and displaying a pharmaceutical skill worthy of special encomium. I found in the elixirs where iron was combined with the alkaloids of Peruvian bark and other ingredients, the following proportions, taking the average of several assays:

	Amount of Alkaloid required in Oj.	Amt. Alkaloid claimed in Oj.	Amt. Alkaloid found in Oj.	Salts of Iron found in Oj.
Elixir Iron, Quinia, and Strychnia.	$130\frac{2}{15}$	$130\frac{2}{15}$	Grs. 106 Alkaloid equiv. to 128 Grs. Sulp. Quin. and Strych.	
" Bark, Iron, and Bismuth.....	19.20	19.20	$20\frac{1}{2}$	233
" " " " Strychnia...	21.76	21.76	20	250
" Cinchona Ferrat..................	19.20	19.20	21	253
" " Calisaya..............	19.20	19.20	20	
Wine Calisaya..............................	19.20	19.20	19	
Bitter Wine of Iron........................	19.20	19.20	18	246

A number of other preparations were treated, and gave very satisfactory results and evidences of strict adherence to the quantity of drug contained in them as claimed by this firm. Among those tested were:

Elixir Ammonio-Cit. Bisulph.
" Bismuth and Strychnia.
" Valerian Ammon.
" Gentian and Tinct. Ferri Chlor.
Syrup Hypophos. Comp.
" Lacto-Phosp. Lime.

These elixirs seem to be a real advance in pharmacy, as they represent strength and

virtues with comparatively much less disagreeable taste than the same ingredients as usually made and extemporaneously prepared.

In the combinations containing alkaloids of Peruvian bark, the absence of intense bitterness is evidently due to quinia being used instead of sulphate of quinia, as is usually the case; consequently the addition of acid is not requisite to insure solution, and the bitterness of the salt is not fully developed.

Saccharated Pepsin fully proved its value by testing a small sample of 30 grains, which, at a temperature of 100° F. in eight hours, dissolved over 400 grains coagulated albumen. It is only equaled by that made by Mr. Scheffer, of Louisville.

Samples of butter of cacao suppositories were examined, and for precision in admixture of drug, regularity in size of cone, and nice skill in incorporating the various ingredients, are worthy of special mention. Butter of cacao alone was used.

The very large variety of pills exhibited by this firm and others precluded the assay of any varieties other than those containing the alkaloids of Peruvian bark. The compressed pills as manufactured by this firm appear to be of most uniform character in size, weight, and quality, and in all instances contained the amount represented.

The important feature in the pills appears to be their reduced size, and the absence of any excipient. The five-grain pills quiniæ sulp. are smaller than the three-grain pills as made usually in the shops.

In our judgment, these compressed pills are for above reasons, viz., smaller size, absence of excipients, and speedy solubility, superior to any other pills manufactured.

3. Rigand & Dusard, Paris, France.

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for the excellent preparations of chloral-hydrat and pancreatin.

4. Rovul, Bravais, & Co., Paris, France.

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for the very good preparations of dialized iron.

5. Valby, Dijon, France.

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for the excellent capsulated preparations.

6. Vie-Garnier & Co., Paris, France.

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for their beautiful collection of dragées, showing a remarkable perfection in manufacture.

7. Ch. Torchon, Paris, France.

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for the very beautiful preparation of chloral-hydrat.

8. A. Beslier, Paris, France.

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for his very good plaster of cantharides and thapsia; also for his revulsive and epispastic papers.

9. **Antonio José Rodrigues d'Araujo, Rio de Janeiro, Brazil**

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for fine exhibits of beautifully prepared pharmaceutical preparations, showing marked progress.

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10. **Leão & Alves, Porto Allegre, Province of Rio Grande do Sul, Brazil.**

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for a remarkably fine collection of medicinal oils. The castor oil exhibited by this firm is the finest on exhibition.

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11. **Ferreira, Maia, & Co., Pernambuco, Brazil.**

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for his fine preparations of jurubeba and other pharmaceutical preparations indigenous to the country.

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12. **Dupuy Barthelemy, Brussels, Belgium.**

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for the variety and extent of exhibit, and for carefulness of preparation.

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13. **Ernst Jebens, Baden-Baden, Germany.**

PHARMACEUTICAL PREPARATIONS.

Report.—Commended for the beauty and variety of pharmaceutical products, especially the salicylic acid preparations.

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14. **Joseph Bosisto, Richmond, Melbourne, Victoria, Australia.**

CHEMICAL AND PHARMACEUTICAL PREPARATIONS FROM THE EUCALYPTUS GLOBULUS.

Report.—Commended for variety and extent of the collection of medicinal preparations, for the capacity and industry shown in developing the indigenous materia medica, and for the scientific benefit arising from the opportunity afforded for accurate experiment upon the medicinal properties of the eucalyptus.

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15. **Boericke & Tafel, Philadelphia, Pa., and New York, N. Y., U. S.**

HOMŒOPATHIC PREPARATIONS.

Report.—Commended for extent, completeness, and general beauty of the exhibit.

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16. **Wilhelm & Co., Vienna, Austria.**

DRUGS.

Report.—Commended for the completeness of the exhibit of drugs and pharmaceutical preparations.

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17. **I. Bernhardi, Leipsic, Germany.**

DRUGS.

Report.—Commended for completeness and variety.

18. Della Suda (Fayk Pasha), Constantinople, Turkey.

DRUGS.

Report.—Commended for the completeness of the display of many different kinds of scammonium and opium, and for the other pharmaceutical preparations.

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19. E. F. Houghton & Co., Philadelphia, Pa., U. S.

COSMOLINE.

Report.—Cosmoline is a heavy, paraffinous, oleaginous hydro-carbon, without affinity for oxygen or moisture. The specimens exhibited by this firm are absolutely pure, and as a vehicle for the administration of medicines in the shape of ointment it is invaluable.

Commended for absolute purity, great utility in pharmacy, and for cheapness.

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20. Emil Scheffer, Louisville, Kentucky.

PEPSIN.

Report.—Commended for purity of the pepsin obtained by the process originated by this manufacturer, efficiency, and reliability, rendering it a valuable article of the materia medica.

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21. A. Hottot & Co., Paris, France.

PEPSIN.

Report.—Commended for the exhibit of remarkably pure pepsin.

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22. Prof. Modeste Kittary, St. Petersburg, Russia.

DISINFECTING POWDERS.

Report.—Commended for the good composition of the exhibited powders, which avoids waste of carbolic acid and renders its odor less disagreeable, and for the impalpability of the powder, which secures its perfect diffusion in the air and upon surfaces.

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23. Bobœuf (Société Anonyme d'Exploitation de Produits Hygiéniques), Paris, France.

PHENOL.

Report.—Commended for the fitness of the exhibited phenol preparations for the purpose of disinfection.

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24. Marvin Brothers & Bartlett, Portsmouth, N. H., U. S.

COD-LIVER OIL (PHARMACEUTICAL PREPARATION).

Report.—This oil has been examined with all the usual tests, and it is found that in every respect the reactions give indications of its containing all the constituents and therapeutic properties of pure cod-liver oil.

It is a very light straw color, not so white as to show the use of chemicals, nor so dark as to give evidence of being manufactured from livers kept for days before being expressed. The oil is perfectly sweet, entirely free from any disagreeable odor, and the claim of Messrs. Marvin Brothers & Bartlett, that it is prepared from fresh livers only, is well founded.

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25. Peter Möller, Christiania, Norway.

COD-LIVER OIL.

Report.—Commended for a very fine and perfectly pure specimen of cod-liver oil.

26. Christian Johnsen, Christiansand, Norway.

COD-LIVER OIL.

Report.—Commended for a very fine and perfectly pure specimen of cod-liver oil.

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27. José Duarte Dias, Rio de Janeiro, Brazil.

DRUGS AND OILS.

Report.—Commended for fine preparation of balsam of copaiba, medicinal oils, and tinctures.

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28. Henry Bower, Philadelphia, Pa., U. S.

GLYCERINE.

Report.—The finest exhibit of glycerine presented for examination; pure and inodorous.

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29. Robert Shoemaker & Co., Philadelphia, Pa., U. S.

DRUGS AND FLUID EXTRACTS.

Report.—Commended for the general excellence of every article exhibited.

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30. Robert A. Hance, Philadelphia, Pa., U. S.

FLUID EXTRACTS (MEDICINAL).

Report.—Commended for the excellent quality of the medicinal fluid extracts exhibited.

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31. Mellor & Rittenhouse, Philadelphia, Pa., U. S.

EXTRACT OF LICORICE IN MASS AND ROLLS.

Report.—Commended for its cheapness as compared with foreign brands of the same quality, its purity, and excellence of manufacture.

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32. Frederick Brown, Philadelphia, Pa., U. S.

ESSENCE OF JAMAICA GINGER, AND OTHER PHARMACEUTICAL COMPOUNDS.

Report.—Commended for excellence of the preparation of ginger, which is free from any adulteration, low price of the article, and general excellence of all his pharmaceutical preparations.

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33. Wallace Brothers, Statesville, N. C., U. S.

INDIGENOUS PLANTS USED IN MEDICINE.

Report.—Commended for the extent, variety, completeness, and general perfection of the exhibit.

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34. B. O. & G. C. Wilson, Boston, Mass., U. S.

PRESSED MEDICINAL HERBS, LEAVES, AND FLOWERS.

Report.—A beautiful collection; the dried leaves and flowers retaining the color and odor of the fresh plants.

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35. W. R. Warner & Co., Philadelphia, Pa., U. S.

SUGAR-COATED PILLS.

Report.—The sugar-coated pills of W. R. Warner & Co. are soluble, reliable, and unsurpassed in perfection of sugar-coating, thorough composition, and accurate subdivision. The pills of phosphorus are worthy of special notice; the element is thoroughly diffused and subdivided, yet perfectly protected from oxidation.

36. Limousin, Paris, France.

MEDICATED CAPSULES.

Report.—Commended for the very good preparations of chloral-hydrat and for the *cachets de pain* exhibited.

37. H. Planten & Son, New York, N. Y., U. S.

GELATINE CAPSULES FOR LIQUID AND SOLID SUBSTANCES.

Report.—Commended for general excellence in manufacture.

38. H. Ledger & Co., London, England.

EXTRACT OF MEAT.

Report.—Commended for the perfect preservation of the qualities of meat, and for its good flavor.

39. H. Naumann-Burkhardt, Basle, Switzerland.

EXTRACT OF MEAT.

Report.—The extract of meat exhibited is excellent in taste, well manufactured, and stands every comparison with other products of that kind.

40. Mann S. Valentine, Richmond, Va., U. S.

VALENTINE'S MEAT JUICE.

Report.—Commended for excellence of the method of its preparation, whereby it more nearly represents fresh meat than any other extract of meat; its freedom from disagreeable taste, its fitness for immediate absorption, and the perfection in which it retains its good qualities in warm climates.

41. J. H. Gemrig, Philadelphia, Pa., U. S.

SURGICAL INSTRUMENTS.

Report.—Commended for the finest assortment of eye instruments. The eye instruments manufactured by this exhibitor are perfect in every respect. The lightness, exquisite finish, and perfect balance of the instruments place them at the head of all competitors. The same may be said of the ear instruments.

42. Merino & Co., Rio de Janeiro, Brazil.

SURGICAL INSTRUMENTS.

Report.—Commended for the marked improvement in the manufacture of surgical instruments.

43. Mayer & Meltzer, London, England.

SURGICAL INSTRUMENTS AND GALVANIC BATTERIES.

Report.—Commended for a large display of surgical instruments of excellent material and finish; for new instruments for the surgical treatment of the urethra; and for the practical efficiency of their galvano-caustic apparatus.

44. George Tieman & Co., New York, N. Y., U. S.

SURGEONS' INSTRUMENTS.

Report.—Commended for a fine display of general instruments, especially for amputating and gynæcological cases.

45. Rondeau Brothers, Paris, France.

RUBBER SURGICAL INSTRUMENTS.

Report.—Commended for the very good workmanship of the exhibited rubber catheters and bougies.

46. Vergne & Chose Brothers, Paris, France.

RUBBER SURGICAL INSTRUMENTS.

Report.—Commended for good workmanship.

47. Jean-Pierre Benas, Paris, France.

RUBBER SURGICAL INSTRUMENTS.

Report.—Commended for good workmanship.

48. Morris Mattson, New York, N. Y., U. S.

HARD RUBBER SYRINGES.

Report.—Commended for invention of syphonic application by his syringe of dry heat or cold to either rectum or vagina; for his vaginal irrigator, and good manufacture in general.

49. National Surgical Institute, Indianapolis, Ind., U. S.

ORTHOPEDIC AND OTHER SURGICAL APPLIANCES.

Report.—Commended for originality of inventions in orthopedic appliances, beauty of workmanship, adaptability for all the purposes designed, and variety of appliances for meeting different indications; also for a very ingenious bath chair for administering hot air and medicated vapors.

50. E. Weiskopf, New York, N. Y., U. S.

OPHTHALMOSCOPES AND LARYNGOSCOPES.

Report.—Commended for superiority of design, excellence of construction, and admirable adaptability for all purposes of physical examination by reflected light.

51. D. W. Kolbe, Philadelphia, Pa., U. S.

ORTHOPEDIC INSTRUMENTS.

Report.—Commended for the most practically constructed and best finished orthopedic instruments, combining durability and adaptability with moderate cost.

52. W. A. Hirschmann, Berlin, Germany.

ELECTRO-THERAPEUTIC APPARATUS.

Report.—Commended for the small apparatus in which a thermo-electrical battery is used as the source of the inducting current.

53. W. G. A. Bonwill, Philadelphia, Pa., U. S.

ELECTRO-MAGNETIC MALLET.

Report.—Commended for originality and great practical usefulness.

54. Dr. Jerome Kidder, New York, N. Y., U. S.

GALVANIC APPARATUS.

Report.—Commended for the scientific basis and the excellent workmanship of all the exhibited apparatus; for the introduction of a new method to obtain very rare interruptions from a self-acting interruptor; for the fitness for the purpose of changing the quality and quantity of the galvanic current; and for the very good construction of galvano-caustic apparatus.

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55. Galvano-Faradic Manufacturing Co., New York, N. Y., U. S.

GALVANIC APPARATUS.

Report.—Commended for the completeness of the supply of apparatus in the large electro-medical case; for the simple and ingenious way in which the frequence of interruptions of the inducting current can be changed; for the fitness of the electrodes for applications to the different parts of the body; and for the effectiveness and simplicity of construction of the galvano-caustic battery with agitator.

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56. Flemming & Talbot, Philadelphia, Pa., U. S.

GALVANIC APPARATUS.

Report.—Commended for the good construction of large and transportable galvanic batteries, for the simplicity of construction of induction apparatus, and for the excellent workmanship of the whole exhibit.

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57. Prof. L. Waldenburg, M.D., Berlin, Germany.

PNEUMATIC APPARATUS.

Report.—Commended for the invention and introduction of a simple and exact physiological principle into medical practice, and for the ingenious construction of an apparatus which is well suited to secure the purposes desired, namely, the inhaling either condensed or rarefied air, and exhaling into rarefied air.

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58. Geo. Tieman & Co., New York, N. Y., U. S.

THERMOMETERS AND GALVANO-CAUSTIC APPARATUS.

Report.—Commended for excellent construction, workmanship, and applicability of clinical thermometers and Dawson's galvano-caustic apparatus.

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59. James Joseph Hicks, London, England.

THERMOMETERS AND URINOMETERS.

Report.—Commended for the excellent workmanship of urinometers and thermometers. In the instruments the scale is protected by a thin layer of glass.

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60. Samuel Adger Darrach, Newark, N. J., U. S.

RAWHIDE APPARATUS FOR SPINAL CURVATURE; ALSO HIP- AND KNEE-JOINT AND BOW LEG APPARATUS.

Report.—Commended for originality of this use of the material, the ease and perfection with which it can be moulded to deformed shapes, its subsequent lightness, firmness, perfect support afforded, and its comfort to the patient; for the simple, firm, and effective mode in which proper and needed force can be applied and maintained in any direction, and for the permanent security and comfort of the counter-extension secured.

61. Vyvodzef, M.D., St. Petersburg, Russia.

APPARATUS FOR EMBALMING BODIES.

Report.—Commended for the invention of a very ingenious apparatus for the purpose of injecting liquids into blood-vessels; for the general applicability of this apparatus for every kind of liquids and blood-vessels; for the introduction of a thymol solution as an excellent preserving substance, which makes parts of human bodies injected with it half a year ago look like fresh ones.

62. B. Frank Palmer, LL.D., Philadelphia, Pa., U. S.

ARTIFICIAL LIMBS.

Report.—Commended for the marked superiority in all the qualities which should characterize instruments of this class. They are capable of adaptation to every form of mutilation of the lower limbs; are light, strong, of admirable workmanship in every part, exquisitely modeled and finished, and provide in their mechanism for the most natural imitation of the movements of the living limb, while affording adequate and assured support to the wearer.

The first patent was granted to B. F. Palmer in 1846, since which time, with great perseverance and skill, he has added many improvements, which have found expression in a variety of patents; but the last is by far the most important, being what the inventor calls a "safety socket." It is designed to receive a part or the whole of the weight of the wearer upon the end of the stump, a mode of treatment so radically different from the existing ideas and practice as to merit the rank of a discovery. The testimony offered and examined of the complete adaptation of this invention to its application leaves no room for doubt that this last contribution to the comfort and relief of the mutilated is the most important of his beneficent labors.

A production which embodies the intelligent effort of a lifetime, and which affords the utmost compensation for one of the direst forms of human misfortune, entitles its author to a position in the front rank of the inventors and mechanics of the age. The artificial arms of the same maker are ingenious and well made, but, from the necessities of the case, cannot bear comparison with the admirable invention of the leg. The limitations of human art in the attempt to supply the loss of hand or arm are obvious to the slightest reflection. Beyond the improved appearance given to the wearer, they are comparatively of little service.

63. Samuel Adger Darrach, Newark, N. J., U. S.

WHEELED CRUTCHES.

Report.—Commended for originality of design, perfection of mechanism, general suitability to the purposes desired, and demonstrated usefulness.

64. Crandall & Son, New York, N. Y., U. S.

CRUTCHES.

Report.—Commended for strength, lightness, convenience and ease in use, cheapness, and durability.

65. J. T. Woods, M.D., Toledo, Ohio.

SPLINT FOR LEG AND THIGH.

Report.—Commended for facility of application to simple or compound fractures of the lower limbs of persons of different sizes or ages, and upon either side of the body; for subsequent firmness of support, convenience of making examination or dressings, or effecting and securing changes of position of the limb desirable for comfort or treatment.

66. G. Hayden Day, Bennington, Vt., U. S.

FRACTURE SPLINTS.

Report.—Commended for the most complete, durable, and efficient set of wooden splints on exhibition. Their simplicity renders them equally valuable for hospital and private practice.

67. Dr. David Ahl, Newville, Cumberland County, Pa., U. S.

ADAPTABLE POROUS SPLINTS.

Report.—Commended for lightness, firmness, flexibility, and cheapness.

68. Hippolyte Guillery, Brussels, Belgium.

ZINC SPLINTS.

Report.—Commended for general applicability and fitness and cheapness of the exhibited perforated zinc splints.

69. Elastic Truss Co., New York, N. Y., U. S.

TRUSSES.

Report.—An admirable invention, doing away with the necessity of springs or back support for many varieties of rupture.

70. E. C. Penfield & Co., Philadelphia, Pa., U. S.

TRUSSES.

Report.—Commended for general beauty of finish, excellence of spring, and adaptability for every variety of rupture.

71. Wm. H. Horn & Brother, Philadelphia, Pa., U. S.

TRUSSES.

Report.—The neck is of Swedish or Norway iron, allowing easy adaptation of position of the pad and direction of the force of the spring to each case. Commended for good workmanship and materials, extreme simplicity of construction, cheapness of original cost, and proved effectiveness and durability.

72. Philadelphia Truss Co., Philadelphia, Pa., U. S.

TRUSSES.

Report.—Commended for their combination giving all necessary and possible movements of the pad upon the steel spring for fitting each person, combined with entire firmness and stability; also for general display of trusses of excellent material and workmanship.

73. I. B. Seeley, Philadelphia, Pa., U. S.

TRUSSES.

Report.—Commended for perfect and enduring coating of steel spring by vulcanized rubber, preventing rust, allowing also change of shape of spring without injury to rubber coating, which assists in maintaining the spring in its modified shape; for excellent material and workmanship, and general suitability to secure the ends desired in this class of instruments.

74. Bartlett, Butman, & Parker, Chicago, Ill., U. S.

COMMON-SENSE TRUSS.

Report.—Commended for originality in the use of the mechanical arrangement for securing proper place and permanency of position to the pad, and direction of the retaining force of the spring; for excellent workmanship and quality of materials, general fitness for the purposes intended, cheapness of original cost, and durability.

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75. Seabury & Johnson, New York, N. Y., U. S.

PLASTERS.

Report.—Commended for originality of the invention for the combination of medicinal agents with india rubber in the form of plasters, reliability, and general excellence in manufacture.

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76. Paper and Chemical Factory, Helfenberg, Saxony, Germany.

ADHESIVE PLASTER DRESSING SUBSTANCES AND ICE BAGS.

Report.—Paper has been used for many and not common purposes in surgery,—principally for ice bags. It is superior to animal substances, as it does not decompose, and is much cheaper. The ice bags of the paper and chemical factory of Helfenberg are the only ones here exhibited. The exhibits for the appliance of plasters are of practical importance, and show good workmanship.

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77. Dr. A. Matthijsen, Budel, Netherlands.

PLASTER AND BANDAGES.

Report.—Commended for the original invention, and for the great practical value thereof.

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78. Rigollot & Co., Paris, France.

MUSTARD PLASTER.

Report.—Commended for effectiveness.

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79. Alfred William Gerrard, London, England.

SUPPOSITORIES AND MUSTARD PLASTERS.

Report.—Commended for excellence of workmanship and materials.

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80. Dr. Port, Surgeon in the Bavarian Army, Munich, Germany.

DRESSING FOR FRACTURES CAUSED BY SHOOTING.

Report.—Dr. Port exhibited a set of dressings for fractures from shot wounds. He only uses for them willow whips, iron plate, and twine. They are very easily made and applied. They fix the limb perfectly, allow many changes in position, and application of other bandages, and are of great value for field service.

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81. Surgical Clinic of the University of Königsberg, Königsberg, Germany.

GYPSUM HEMP BANDS.

Report.—The gypsum hemp bandages for the treatment of fractures and inflammations of the joints represent a new material for that purpose. They can be readily adapted in every position of the limb, easily made and detached; for transport they are of great value. The material is very cheap, and can be had everywhere.

82. Dr. Bernhard Beck, Surgeon-General 14th Corps of Army, Carlsruhe, Baden, Germany.

ARTICLES FOR FIRST DRESSING AND FOR TRANSPORTATION IN THE WAR.

Report.—Dr. Beck exhibited straw splints and stretchers for the first dressing and transporting wounded soldiers from the field. The great value of such bandages as first means of help lies in the readiness of manufacture by unprofessional men.

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83. International Bandage-Shiff Factory, Schaffhausen, Switzerland.

DRESSINGS, LINT, AND APPLIANCES FOR THE DRESSING OF WOUNDS.

Report.—The dressings and appliances for the dressing of wounds consist of carbolized material in connection with splints, etc. Medical knapsacks are composed from that material, for the use of fire companies, railways, etc. The whole exhibit was intended for a sanitary pavilion, and is the worthiest and most complete one of all those made in that direction. The material is a very good one.

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84. Paul Hartmann, Heidenheim, Germany.

PREPARED MEDICAL DRESSING MATERIAL.

Report.—Commended for a complete set of all dressing materials as they are in connection with Lister's method. The material of the dressings itself is very good; equally so the impregnation with carbolic acid.

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85. Prof. Dr. Friedrich Esmarch, Kiel, Germany.

HOSPITAL DRESSINGS AND DRAWINGS.

Report.—Dr. Esmarch exhibited drawings of his method for bloodless operations. The dressings and apparatus for nursing the sick are excellent in their close manner of packing and the completeness of the contents, the use of which is well and clearly explained in his books.

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86. Vincent Perry, Germantown, Pa., U. S.

ELASTIC BANDAGES FOR SURGICAL PURPOSES.

Report.—Commended for general excellence in manufacture.

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87. H. D. Justi, Philadelphia, Pa., U. S.

ARTIFICIAL TEETH.

Report.—Commended for strength and natural life-like appearance.

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88. Samuel S. White, Philadelphia, Pa., U. S.

ARTIFICIAL TEETH.

Report.—1. That, while equal to all others in color, texture, and translucency, they are decidedly superior in a faithful reproduction of the physiological characteristics of the natural organs, both to the individual teeth and relatively to the entire set.

2. Their conformation with reference to close and easy adaptation to the maxillary arch shows careful study of needs of both patient and operator.

3. For the various and numerous deviations from uniformity of arch and outline simulating the irregularities of nature, which thereby disarm suspicion of their artificial nature.

4. For the skillful distribution of tooth material in such manner as to secure the greatest

amount of strength with the least bulk and weight, and for the peculiar form and insertion of the platinum pins.

For the maintenance of these good qualities through an immense variety of size, color, and form of each class of teeth, excelling any other exhibit.

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89. Dr. Adolf Zsigmondy, Vienna, Austria.

MODELS OF TEETH, MADE OF PLASTER AND GYPSUM DRESSING.

Report.—Commended for exactness and neatness of workmanship; especially for their great value in exhibiting certain very serious deformities of the teeth and jaw, and the marked relief from such deformities which can be effected by the scientific uses of surgical and mechanical appliances.

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90. E. Parmly Brown, Flushing, Long Island, N. Y., U. S.

SPECIMENS OF OPERATIVE DENTISTRY.

Report.—Commended for careful and thorough workmanship.

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91. Dr. F. A. Berghammer, Vienna, Austria.

MECHANICAL DENTISTRY.

Report.—Commended for the general display of different methods of mounting artificial teeth, all of excellent workmanship. For continuous gum work, showing careful manipulation, with a due regard to facial expression.

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92. John Spencer, Sydney, New South Wales, Australia.

MECHANICAL DENTISTRY.

Report.—Commended for excellence of workmanship

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93. Noel Winderling Brothers, Milan, Italy.

DENTAL MUSEUM.

Report.—Commended for its absolute completeness and perfection, displaying the anatomy of the teeth from early fœtal life to their total disappearance, giving a complete view of dental physiology and pathology, of dental anomalies, and of dental orthopedic operations; also for the patient and skilled labor of years necessary to create this admirable exhibit.

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94. Samuel S. White, Philadelphia, Pa., U. S.

DENTISTS' INSTRUMENTS.

Report.—Commended for their strength, temper, finish, and suitability of form for the purposes for which they were designed.

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95. Codman & Shurtleff, Boston, Mass., U. S.

DENTAL INSTRUMENTS, FURNITURE, AND INHALER.

Report.—Commended for the extent, comprehensiveness, and variety of the exhibit, the skillful adaptation of the instruments and furniture to their several purposes, and for superior quality and finish; also for novelty of design of the inhaler, perfection of its execution, and general suitability to the rapid and safe administration of anæsthetics.

96. Horatio C. Kern, Philadelphia, Pa., U. S.

DENTAL EXTRACTING FORCEPS.

Report.—Commended for their construction, the beaks of the forceps being adapted to the anatomical forms of the various teeth to be extracted. For the excellence of material and workmanship.

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97. Jacob J. Teufel, Philadelphia, Pa., U. S.

DENTAL FORCEPS.

Report.—An elaborate display of dental forceps, well finished and admirably adapted for their purpose.

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98. Samuel S. White, Philadelphia, Pa., U. S.

DENTAL CHAIRS.

Report.—Commended for the ease and rapidity with which the chair is changed from a low to a high position, and the reverse movement; for the facility with which the chair and seat may be thrown from a horizontal to an inclined position, being securely held at any desired point; for the ease and rapidity with which the back of the chair may be raised and lowered, and the angle changed so as to give support as may be desired; for novelty and value of arm and body of chair; for variety of movement of the head-rest, with but one locking lever; for swinging movement of the whole body, and yet secure locking in any position.

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99. Samuel S. White, Philadelphia, Pa., U. S.

DENTAL ENGINES.

Report.—As a whole, they are valuable adjuncts to the practitioner of dentistry. In particular for the flexible shaft and sheath, the plate spring pitman, the hand piece, and the extension treadle, are valuable improvements. The water dental engine is commended for its neatness, compactness, and power, is simple in its management and completely under control; commended also for excellence of material and construction.

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100. Quincy A. Scott, Pittsburg, Pa., U. S.

ATMOSPHERIC DISC; DENTAL WORK.

Report.—Commended for invention and application of atmospheric disc for retaining artificial teeth in place, a valuable acquisition to dentistry in certain conditions of the mouth; also for excellence in finish of general dental work exhibited.

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101. William Valleau, Jr., New York, N. Y., U. S.

DENTAL GOLD-FOIL.

Report.—Commended for purity, brilliancy of color, and variety and convenience of forms for the use of the operator.

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102. Charles Abbey & Sons, Philadelphia, Pa., U. S.

GOLD-FOIL.

Report.—Commended for its uniform purity, softness, and strength.

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103. Ludwig Müller-Uri, Lauscha, Germany.

ARTIFICIAL HUMAN EYES.

Report.—Commended as being the most perfect and natural artificial eyes in form and finish.

104. Dr. Adam Politzer, Vienna, Austria.

ANATOMICAL PREPARATIONS.

Report.—A splendid exhibit of many very carefully made and most instructive preparations on the labyrinth of the human ear, and a very fine atlas on otology.

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105. H. W. Heckelmann, M.D., Allegheny City, Pa., U. S.

ANATOMICAL PREPARATIONS.

Report.—Commended as the most instructive preparation on the muscles, nerves, and blood-vessels of the human eye, and for the very fine collection of preparations on the labyrinth of the human ear.

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106. Bavarian Association for Aiding Wounded and Sick Soldiers, Munich, Germany.

MODEL OF A FULLY-DRESSED MEMBER OF THE VOLUNTARY SANITARY CORPS.

Report.—The Central Committee of the Bavarian Association for Nursing and Aiding Wounded and Sick Soldiers exhibited a model of a fully-dressed and completely equipped member of the volunteer sanitary corps. The arrangement is very complete and easily carried.

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107. N. Plambeck, Hamburg, Germany.

MODEL OF A HOSPITAL CAR.

Report.—An arrangement for making use of freight cars for the first transport of wounded and sick before the regulation trains arrive. The idea is a very good one. The system is such that it can be used in any car on all railroads. The whole material can at any time be transported in one car, so that it can be used on the place when it may be needed.

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108. Lower Silesian and Markish Railway, Berlin, Germany.

MODELS OF A SANITARY TRAIN.

Report.—The models of railway cars for the transport of sick and wounded and kitchen car are very good in their manufacture as well as plan of construction. It is clearly shown thereby in what manner the sanitary trains of the German army are now arranged.

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109. Emile De Jean, Brussels, Belgium.

COLLECTION OF MODELS OF HORSESHOES.

Report.—A most interesting collection of small iron models of horseshoes for the different physiological and pathological conditions of the hoof.

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110. Edward Lipowsky, Heidelberg, Germany.

APPARATUS FOR TRANSPORTING SICK AND WOUNDED.

Report.—The exhibit comprises a set of stretchers, beds, mattresses, etc., for the transport and treatment of sick and wounded. These articles distinguish themselves by originality of invention, good work, and cheapness.

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111. T. McElroy, New York, N. Y., U. S.

INVALID BEDSTEADS AND OPERATING CHAIR.

Report.—Commended for special value of the inventions to invalids, and those suffering from fractures, and to the surgeon for the facility with which the patient can be placed and retained in any desired position.

112. Dr. Krassinsky, Novo-Mirgorod, Kherson, Russia.

MICROSCOPICAL PREPARATIONS.

Report.—A large collection of very well finished and most instructive microscopical preparations of normal and diseased human tissues and organs.

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113. Chas. Fayette Taylor & Thos. M. Ludlow Christie, New York, N. Y., U. S.

ORTHOPEDIC AND LOCAL EXERCISES APPARATUS.

Report.—Commended for capability of modification of the orthopedic apparatus by the professional attendant to indications as they appear during the progress of the case, illustrating that the treatment of joint diseases is the business not of the mechanic but of the surgeon; for number and completeness of working models of apparatus well suited to secure passive motion in all directions, the force being completely under control and easily modified to suit the necessities of each case.

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114. Gustaf Zander, M.D., Stockholm, Sweden.

APPARATUS FOR MECHANICAL GYMNASTICS.

Report.—Dr. Zander applies engine power to gymnastic purposes, and secures a very useful way for active and passive movement. His engines, being of the best workmanship, can be managed very easily.

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115. Dr. W. Zuelzer, Berlin, Germany.

REPRESENTATION OF SANITARY STATISTICS.

Report.—Dr. Zuelzer has drawn up a graphical representation of the sanitary statistics in Germany for the years 1872–1874. Hygienic lines and curves illustrate the course of phthisis, enteric fever, and cholera in Germany during 1872–1874. The work is one of great labor, and deserves much credit for the compilation and the information arising from the graphical representation of the result. Such important works can only be of benefit if worked up in the different countries on a large scale.

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116. German Association for Aiding Wounded and Sick Soldiers.

REPORTS OF HOSPITAL ASSOCIATIONS.

Report.—The central committee of the German associations has exhibited a full set of reports on the activity of the associations, and a photographic album of the sanitary objects in the Vienna Exhibition. The completeness of the collection gives a full idea of the service done by the voluntary help during the last war, and deserves to be awarded as a source of information for all interested in those matters.

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117. Conrad Brandel, Warsaw, Russia.

ATLAS.

Report.—An atlas containing a number of pictures, admirably executed, illustrating different diseases of the human body.

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118. Alfred A. Gilbert, Philadelphia, Pa., U. S.

MEDICINE CHESTS AND MEDICAL SADDLE BAGS.

Report.—Commended for general excellence in manufacture, combining strength, economical arrangement of space, and beauty of finish.

119. **Hance Brothers & White, Philadelphia, Pa., U. S.**

CONICAL PLATE DRUG MILL AND PERCOLATOR.

Report.—A remarkably simple and well constructed drug mill, cheap and efficient; also an excellent percolating apparatus.

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120. **Pedras Salgadas Mineral Water Co., Oporto, Portugal.**

MINERAL WATERS.

Report.—Waters from springs Penedo and Rebordechão, having alkalinity and sparkling qualities bearing a favorable comparison with the well-known Vichy waters of France.

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121. **R. Blackwood & Co., Montreal, Canada.**

MINERAL WATERS.

Report.—Commended for the excellent quality of their Belfast ginger ale and lemonade.

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122. **Charles Wilson, Toronto, Canada.**

MINERAL WATERS.

Report.—Commended for the excellence of his soda and potash waters.

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123. **Royal Prussian Administration of Mineral Waters, Ems, Germany.**

MINERAL WATERS.

Report.—Commended for the variety of mineral waters exhibited of approved value in a large number of human ailments.

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124. **Municipal Direction of the Bitter Water, Püllna, Austria.**

NATURAL MINERAL WATER.

Report.—Commended for good method of preparation for exportation, and admirable and well-known medicinal qualities of the water.

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125. **Vedago Mineral Waters Co., Lisbon, Portugal.**

NATURAL MINERAL WATERS.

Report.—Commended for antacid and soothing properties to the mucous membranes from the presence of bicarbonate of soda and free carbonic acid gas in large quantity.

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126. **Bolen & Byrne, New York, N. Y., U. S.**

MINERAL WATERS AND SIPHONS.

Report.—Commended for excellence and variety of waters exhibited, for the method of keeping them unaltered by chemical action or by loss of carbonic acid gas; a valuable addition to the means of preserving and restoring health.

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127. **Inman & Brothers, Huddersfield, Yorkshire, England.**

AERATED MEDICINAL WATERS.

Report.—Commended for variety, perfect imitation, and beautiful preparation of aerated medicinal waters.

128. William Corry & Co., Belfast, Ireland.

AERATED MEDICINAL WATERS.

Report.—Commended for a very fine exhibit of aerated medicinal waters, careful preparation, and imitation of the natural springs.

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129. Zanni, Constantinople, Turkey.

MEDICAL PREPARATIONS.

Report.—Commended for the excellent quality of the syrup of sarsaparilla and of ferromanganate.

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130. Bewley & Draper, Dublin, Ireland.

GINGER ALE AND LITHIA WATERS.

Report.—Commended for general excellence, possessing in a high degree all desirable qualities.

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131. F. A. Müller, Wiesbaden, Germany.

MODELS OF DISEASED EYES.

Report.—Commended for the extent and variety of the series representing abnormal and diseased eyes, for accuracy and truth to nature, and for its general scientific value.

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132. Annie D. Ramborger, D.D.S., Philadelphia, Pa., U. S.

MECHANICAL DENTISTRY.

Report.—Commended for thoroughness of workmanship and excellence of finish.

SIGNING JUDGES OF GROUP XXIV.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

J. H. THOMPSON, 1, 2, 11, 19, 20, 24, 25, 26, 28, 29, 30, 34, 35, 37, 41, 44, 50, 51, 62, 66, 75, 76, 86, 111, 118, 119, 127, 128.

ERNST FLEISCHL, 3, 4, 5, 6, 7, 8, 12, 13, 16, 17, 18, 21, 22, 23, 27, 32, 36, 38, 42, 45, 46, 47, 49, 52, 54, 55, 56, 57, 58, 59, 61, 68, 78, 104, 105, 112, 117, 123, 129.

C. B. WHITE, 9, 14, 15, 31, 33, 40, 43, 48, 53, 60, 63, 64, 65, 67, 69, 70, 71, 72, 73, 74, 79, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 113, 120, 121, 122, 124, 125, 126, 130, 131, 132.

W. A. ROTH, 10, 39, 77, 80, 81, 82, 83, 84, 85, 103, 106, 107, 108, 109, 110, 114, 115, 116.

SUPPLEMENT TO GROUP XXIV.

REPORTS

OF

JUDGES ON APPEALS.

JUDGES.

JOHN FRITZ, Bethlehem, Pa.
EDWARD CONLEY, Cincinnati, Ohio.
CHARLES STAPLES, JR., Portland, Me.
BENJ. F. BRITTON, New York City.
H. H. SMITH, Philadelphia, Pa.
COLEMAN SELLERS, Philadelphia, Pa.
JAMES L. CLAGHORN, Philadelphia, Pa.
HENRY K. OLIVER, Salem, Mass.
M. WILKINS, Harrisburg, Oregon.
S. F. BAIRD, Washington, D. C.

1. D. W. Kolbe, Philadelphia, Pa., U. S.

ARTIFICIAL LIMBS AND SURGICAL INSTRUMENTS.

Report.—Commended for superior workmanship, quality, and fitness for purpose ot limbs; also for surgical instruments of superior quality and workmanship.

2. A. A. Marks, New York, N. Y., U. S.

ARTIFICIAL LIMBS WITH RUBBER HANDS AND FEET.

Report.—Commended for utility, workmanship, and adaptation to purpose intended.

3. James A. Foster, Philadelphia, Pa., U. S.

ARTIFICIAL LIMBS.

Report.—Commended for utility, workmanship, and fitness for purpose, especially his artificial arms.

4. Dr. J. Allen & Son, New York, N. Y., U. S.

ARTIFICIAL DENTURES.

Report.—A seamless roof of the mouth, with a natural appearance, and an arrangement of the gums by which the sunken portion of the cheeks is restored. Commended for good workmanship and finish.

5. Isaac M. Rhodes, M.D., Hancock, Mich., U. S.

COMBINED INVALID AND FRACTURE EASY-CHAIR AND BED.

Report.—Commended for invention, utility, quality, and fitness for the purpose intended, being especially useful in hospitals.

6. O. A. Frees, New York, N. Y., U. S.

ARTIFICIAL LIMBS.

Report.—Artificial arms and hands of artistic finish and adaptation to purpose intended. and artificial legs, of excellent adaptation to general use in walking, the motion of the ankle joint and foot being very good.

7. J. Condell & Son, New York, N. Y., U. S.

ARTIFICIAL ARMS.

Report.—Useful and well-finished artificial arms and hands, of good workmanship and utility.

8. Dundas Dick & Co., New York, N. Y., U. S.

SOFT CAPSULES OF GELATINE.

Report.—Commended for finish, flexibility, and adaptation to purpose intended.

9. William Holzer, Philadelphia, Pa., U. S.

DRUGGISTS' GLASSWARE, AND CHEMISTS' AND PHILOSOPHICAL GLASS.

Report.—Commended for fine quality, skill, workmanship, and adaptation to purpose intended, especially in chemistry and physics.

10. William P. Wright, Philadelphia, Pa., U. S.

OILED SILK AND MUSLIN.

Report.—Commended for superior quality and adaptation to general use. This silk has been exposed all summer without softening.

11. Joshua Whittemore, Wakefield, Mass., U. S.

CRUTCHES.

Report.—Commended for elasticity of wood composing crutch, and for attachment of rubber pads and sharp point to prevent slipping on ice, etc.; utility, and fitness for the purpose intended.

12. Thomas G. Morton, M.D., Philadelphia, Pa., U. S.

HOSPITAL WARD CARRIAGE.

Report.—Commended for utility and adaptation to purpose intended.

13. McIlvaine Brothers, Philadelphia. Pa., U. S.

GROUND AND POWDERED DRUGS AND DRY PAINTS.

Report.—A good exhibit of powdered drugs and dry paints, finely and evenly powdered.

14. Noel & Co., Seville, Spain.

EXTRACT OF LICORICE PREPARED IN PASTILES, STICKS, ETC.

Report.—Commended for very good quality.

15. **Angelo Menici, Leghorn, Italy.**

EGRO-LEVER LIFT AND APPLIANCES FOR HOSPITALS.

Report.—Commended for utility and adaptation to purposes intended, especially in hospitals.

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16. **Professor Enrico Gennari, M.D., Milan, Italy.**

SURGICAL INSTRUMENTS.

Report.—Commended for good quality and adaptation to purpose intended.

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17. **G. Piltz, Stockholm, Sweden.**

GELATINE SHEETS MEDICATED.

Report.—Commended for utility and especial fitness for purpose intended.

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18. **Dr. Samuel S. White, Philadelphia, Pa., U. S.**

ARTIFICIAL TEETH.

Report.—Commended for superior quality and fitness for purpose, and especially for their great strength, as shown by careful tests in the presence of the committee.

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19. **Dr. E. D. Hudson, New York, N. Y., U. S.**

ARTIFICIAL LIMBS, AND APPARATUS FOR PARALYSIS.

Report.—Well-made, useful arms and apparatus for paralyzed muscles. Commended for utility, workmanship, and adaptation to purpose intended.

SIGNING JUDGES OF SUPPLEMENT TO GROUP XXIV.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

HENRY H. SMITH, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19.
COLEMAN SELLERS, 14.

United States Centennial Commission.

INTERNATIONAL EXHIBITION, 1876.

REPORTS AND AWARDS

GROUP XXV.

EDITED BY
FRANCIS A. WALKER,
CHIEF OF THE BUREAU OF AWARDS.

PHILADELPHIA:
J. B. LIPPINCOTT & CO.
1878.

SYSTEM OF AWARDS

[*Extract from Circular of April 8, 1876.*]

Awards shall be based upon written reports attested by the signatures of their authors.

The Judges will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the Commission of each country and in conformity with the distribution and allotment to each, which will be hereafter announced. The Judges from the United States will be appointed by the Centennial Commission.

* * * * * * * * * * *

Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Each report will be delivered to the Centennial Commission as soon as completed, for final award and publication.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress, and will consist of a diploma with a uniform Bronze Medal, and a special report of the Judges on the subject of the Award.

Each exhibitor will have the right to produce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

ORGANIZATION AND DUTIES OF THE JUDGES.

[*Extract from Circular of May* 1, 1876.]

Two hundred and fifty Judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the Groups to which they have been respect ively assigned. The foreign members of this body have been appointed

by the Commission of each country, in conformity with the distribution and allotment to each, adopted by the United States Centennial Commission. The Judges from the United States have been appointed by the Centennial Commission.

To facilitate the examination by the Judges of the articles exhibited, they have been classified in Groups. To each of these Groups a competent number of Judges (Foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the Departments of Agriculture and Horticulture, which will form temporary exhibitions, have been arranged in special Groups, and Judges will be assigned to them hereafter.

The Judges will meet for organization on May 24, at 12 M., at the Judges' Pavilion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

The Judges assigned to each Group will choose from among themselves a Chairman and a Secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a Judge in each Group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed, by a majority of the Judges in such Group.

The reports of the Judges recommending awards based on the standards of merit referred to in the foregoing System of Awards, must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the Judges on the subject of the Award, together with a Diploma and a uniform Bronze Medal.

Upon matters not submitted for competitive trial, and upon such others as may be named by the Commission, the Judges will prepare reports showing the progress made during the past hundred years.

Vacancies in the corps of Judges will be filled by the authority which made the original appointment.

No exhibitor can be a Judge in the Group in which he exhibits.

An exhibitor, who is not the manufacturer or producer of the article exhibited, shall not be entitled to an award.

The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the Judges. Upon request, he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the Commission relating to awards, subject to an appeal to the Commission.

A. T. GOSHORN,

Director-General.

[*Extract from Director-General's Address to Judges, May* 24, 1876.]

"The method of initiating awards which we have adopted differs in some respects from that pursued in previous exhibitions. In place of the anonymous verdict of a jury, we have substituted the written opinion of a Judge. On this basis awards will carry the weight and guarantees due to individual personal character, ability, and attainments, and to this extent their reliability and value will be increased. It is not expected that you will shower awards indiscriminately upon the products in this vast collection. You may possibly find a large proportion in no way raised above the dead level, nor deserving of particular notice. The standard above which particular merit worthy of distinction begins is for you to determine. In this regard I have only to express the desire of the Centennial Commission, that you should do this with absolute freedom, and when you meet with a product which you consider worthy of an award, we desire you to say, in as few words as you may deem suitable, why you think so.

"This, gentlemen, is all we ask of you in the Departments of Awards. Opinions thus expressed will indicate the inherent and comparative merits, qualities, and adaptations of the products,—information which the public most desires.

"Elaborate general reports and voluminous essays, though of great value as sources of general information, give little aid in determining the reliable or intrinsic merits of particular, individual products.

"The regulations which have been published divide the work of awards into three parts:

"1st. The individual work of the Judges.

"2d. The collective work of the groups of Judges.

"3d. The final decisions of the United States Centennial Commission in conformity with the acts of Congress.

"Each award will thus pass three ordeals, which, doubtless, will be ample and satisfactory."

GROUP XXV.

JUDGES.

AMERICAN.

JOSEPH HENRY, LL.D., Secretary of Smithsonian Institution, Washington, D. C.

F. A. P. BARNARD, S.T.D., LL.D., Columbia College, N. Y.

J. E. HILGARD, Washington, D. C.

J. C. WATSON, Ann Arbor, Mich.

H. K. OLIVER, Salem, Mass.

GEO. F. BRISTOW, New York.

FOREIGN.

SIR WM. THOMSON, LL.D., D.C.L., F.R.S., Great Britain.

JUL. SCHIEDMAYER, Germany.

E. LEVASSEUR, France.

P. F. KUPKA, Austria.

EDW. FAVRE PERRET, Switzerland.

GROUP XXV.

INSTRUMENTS OF PRECISION, RESEARCH, EXPERIMENT, AND ILLUSTRATION, INCLUDING TELEGRAPHY AND MUSIC.

1. CLASS 320.—ASTRONOMICAL, SURVEYING, AND LEVELING INSTRUMENTS.

2. Astronomical instruments, and accessories, used in observatories.

3. Transits, mural circles, equatorials, collimators.

4. Geodetic and surveying instruments. Transits, theodolites, needle compasses. Instruments for surveying under ground in mines, tunnels, and excavations.

5. Nautical astronomical instruments. Sextants, quadrants, repeating circles, dip-sectors.

6. Leveling instruments and apparatus. Carpenters' and builders' levels, hand levels, water levels, engineers' levels.

7. Instruments for deep sea sounding and hydrographic surveying.

8. METEOROLOGICAL INSTRUMENTS AND APPARATUS.

9. Thermometers, pyrometers.

10. Barometers.

11. Hygrometers and rain gauges.

12. Maps, bulletins.

13. Blanks for reports; methods of recording, reducing, and reporting observations.

14. CLASS 321.—INDICATING AND REGISTERING APPARATUS, OTHER THAN METEOROLOGICAL; MECHANICAL CALCULATION. (See also Group XX.)

15. Viameters, pedometers, perambulators.

16. Gas meters.

17. Water meters, current meters, ships' logs, electrical logs.

18. Tide registers.

19. Apparatus for printing consecutive numbers.

20. Counting machines, calculating engines, arithmometers.

21. CLASS 322.—WEIGHTS, MEASURES, WEIGHING AND METROLOGICAL APPARATUS.

22. Measures of length; graduated scales on wood, metal, ivory, tape, or ribbon; steel tapes, chains, rods, verniers, rods and graduated scales, for measuring lumber, goods in packages, casks, etc., gaugers' tools and methods.

23. Measures of capacity for solids and liquids.

24. Weights. Scales and graduated beams for weighing; assay balances, chemical balances. Ordinary scales for heavy weights, weighing locomotives and trains of cars. Postal balances. Hydrometers, alcoometers, lactometers, etc.; gravimeters.

25. CLASS 323.—CHRONOMETRIC APPARATUS.

26. Chronometers. Astronomical clocks. Church and metropolitan clocks. Ordinary commercial clocks. Pendulum and spring clocks. Marine clocks. Watches. Clepsydras, hour glasses, sun dials. Chronographs, electrical clocks. Metronomes.

27. CLASS 324.—OPTICAL AND THERMOTIC INSTRUMENTS AND APPARATUS.
28. Mirrors (for special purposes), plane and spherical.
29. Lenses and prisms.
30. Spectacles and eye glasses, field and opera glasses, graphoscopes and stereoscopes.
31. Cameras and photographic apparatus.
32. Microscopes.
33. Telescopes. (See also Class 320.)
34. Apparatus for artificial illumination, including electric, oxyhydrogen, and magnesium lights.
35. Stereopticons.
36. Photometric apparatus.
37. Spectroscopes and accessories for spectrum analysis.
38. Polariscopes, etc.
39. Thermotic apparatus. Thermometers of all descriptions, maximum, minimum, self-registering, etc.

40. CLASS 325.—ELECTRICAL APPARATUS.
41. Friction matches.
42. Condensers and miscellaneous apparatus, to illustrate the discharge.
43. Galvanic batteries and accessories, to illustrate dynamical electricity.
44. Electro-magnetic apparatus. Electro-magnetic engines (see Class 552).
45. Induction machines, Ruhmkorff coils, etc.
46. Magnets and magneto-electrical apparatus.

47. CLASS 326.—TELEGRAPHIC INSTRUMENTS AND METHODS.
48. Batteries and forms of apparatus used in generating the electrical currents for telegraphic purposes.
49. Conductors and insulators, and methods of support; marine telegraph cables.
50. Apparatus of transmission—keys, office accessories, and apparatus.
51. Receiving instruments, relay magnets, local circuits.
52. Semaphoric and recording instruments.
53. Codes, signs, or signals.
54. Printing telegraphs, for special uses.
55. Electrographs.
56. Dial or cadran systems.
57. Apparatus for automatic transmission.

58. CLASS 327.—MUSICAL INSTRUMENTS, AND ACOUSTIC APPARATUS.
59. Percussion instruments—drums, tambourines, cymbals, triangles.
60. Pianos.
61. Stringed instruments other than pianos.
62. Automatic musical instruments, music boxes.
63. Wind instruments of metal and of wood.
64. Harmoniums.
65. Church organs and similar instruments.
66. Speaking machines.
67. Vocal music.

GENERAL REPORT

OF THE

JUDGES OF GROUP XXV.

INTERNATIONAL EXHIBITION,
Philadelphia, 1876.

PROF. FRANCIS A. WALKER, *Chief of Bureau of Awards:*

SIR,—Herewith I transmit the General Report of the Judges of Group XXV.

Respectfully yours,
J. C. WATSON,
Secretary.

GROUP XXV.

INSTRUMENTS OF PRECISION, RESEARCH, EXPERIMENT, AND ILLUSTRATION, INCLUDING TELEGRAPHY AND MUSIC.

BY J. E. HILGARD.

The members of the Board of Judges assigned to Group XXV. met for organization on the 25th of May, there being present Messrs. Henry, Barnard, Hilgard, Watson, Oliver, and Bristow, of the American Judges, and M. Levasseur, of France. Professor Henry was called to the chair; and Professor J. C. Watson was elected permanent Secretary. Sir William Thomson, of Great Britain, was elected President of the group, Professor Henry consenting to preside until his arrival.

The following assignment of subjects was made to the several Judges, subject to any modification consequent upon the arrival of absent members from abroad:

CLASS 320.—Astronomical and Surveying Instruments: Messrs. Watson, Hilgard, and Kupka, of Austria. Meteorological Instruments and Apparatus: Messrs. Levasseur and Henry.

CLASS 321.—Indicating and Registering Apparatus other than Meteorological: Messrs. Barnard, Hilgard, and Kupka.

CLASS 322.—Weights and Measures, Weighing and Meteorological Apparatus: Messrs. Hilgard, Levasseur, and Kupka.

CLASS 323.—Chronometers, Clocks, Watches, etc.: Messrs. Watson and Favre-Perret, of Switzerland.

CLASS 324.—Optical and Thermotic Instruments and Apparatus: Messrs. Henry and Barnard. Telescopes: Mr. Watson.

CLASS 325.—Electrical and Magnetic Apparatus: Messrs. Thomson, Henry, and Barnard.

CLASS 326.—Telegraphic Instruments and Methods: Messrs. Thomson and Henry.

CLASS 327.—Musical Instruments: Messrs. Oliver, Schiedmeyer, of Germany, Bristow, and Kupka. Acoustic Apparatus: Messrs. Henry and Barnard.

Sir William Thomson and Mr. Schiedmeyer joined the group on June 5, and Mr. Kupka on the 6th. Mr. Charles E. Emery, one of

the Judges in Group XX., was assigned to assist in Group XXV., in the department of Electricity. In the absence of Mr. Favre-Perret, who only arrived on the 20th of June, he was represented by Mr. Gribi, one of the Commissioners from Switzerland, as an expert in the department of Horology. Professor Vogel, of Berlin, was appointed as an expert on the part of Germany in Classes 320, 322, 324, and 326; and Professor Reuleaux, of Germany, in Classes 321 and 322. Dr. Fleischl, of Austria, one of the foreign Judges, was, at the request of Group XXV., assigned to act as a Judge of Microscopes in the group. Sir William Thomson being obliged to leave on June 28, Mr. Hilgard was elected Chairman, and acted as such to the close of the work.

In regard to the general character of the exhibit, it may be said that the most advanced state of science and art was represented in all departments of the group except in that of astronomical and geodesic instruments of the larger class. This arose from the nature of the case, as such instruments are only made to order, and cannot usually be spared from their uses.

CLASS 320.—ASTRONOMICAL, SURVEYING, AND LEVELING INSTRUMENTS—METEOROLOGICAL INSTRUMENTS AND APPARATUS.

This class comprised several distinct categories of scientific instruments: those of astronomy, geodesy, and surveying; instruments for mathematical drawing, hydrographic apparatus, meteorological instruments of all kinds; and in addition to these, chemical and physical apparatus.

The larger class of astronomical instruments was not represented at all, since they are difficult of transport, and are only constructed to order. Of the portable astronomical instruments, the principal exhibit was in the Government collection of the United States, which comprised a complete exhibit of the instruments and apparatus used in the transit of Venus expedition sent out by the United States.

The firm of Faut & Co., of Washington, however, exhibited an equatorial of excellent construction. Its object-glass, of 6½ inches aperture and 8 feet focal length, was made by A. Clark & Sons, of Cambridgeport. The same firm also exhibited a geodesic theodolite of approved construction, which was the only instrument of its class in the Exhibition, beside those in the collection of the United States Coast Survey and United States Engineers.

A portable transit-instrument, made by Edward Kübel, of Washington, for the United States Coast Survey, deserves special mention

here, as it could not receive an award, from the circumstance of its being in the Government exhibit.

In geodesy proper, no other nations could be compared with the United States, because none had sent the instruments and documents relative to the geodesic operations carried on by them; while the United States, on their part, had made a complete and very remarkable exhibition by collecting in the Government Building the maps, instruments, and reports of the Coast Survey and the War Department. Among the instruments which particularly attracted the attention of geodesists, were the apparatus for measuring base-lines, that for comparing the measuring-bars with standards, and the apparatus for determining personal equation in observing transits for time; also the combined instrument for observation of time and latitude, and the chronographic apparatus.

The United States possess an immense territory, almost as large as Europe, which requires to be surveyed and divided into properties, and where a rapidly-increasing population is occupying new lands and building new houses and towns. It is not surprising, therefore, that the fabrication of surveying instruments should be a flourishing branch of industry. There were more than a dozen exhibitors from the United States in this branch, among whom several are distinguished by ingenious detail of construction and perfection of workmanship. The exhibit of Switzerland in the same line of instruments is also worthy of special mention, as well as a leveling instrument of novel design, for work of precision, from Portugal.

In mathematical and drawing instruments, Aarau, in Switzerland, continues to be one of the important centres of manufactures in Europe. Nuremberg, in Germany, produces especially ordinary articles at low prices. The United States are distinguished in this line by the variety of their rulers, straight and curved, in hard rubber. In this category may be mentioned dividing-machines, of which there were several, among which the most remarkable was that of W. A. Rogers, of Cambridge, Massachusetts. Special mention, also, should be made of several forms of motion, exact right-line movement produced by circular motion, the discovery of Professor Chebicheff, of Russia, by which the solution of a heretofore unsolved mathematical problem is attained.

The instruments of hydrography consisted of marine compasses, logs, and sounding apparatus. The compasses of Ritchie, of Boston, were much approved by the Judges, as well as the apparatus of B. F. Greene, exhibited in the United States Navy Department, for correcting compasses on iron ships. In logs, several improvements were

noticed and rewarded. The apparatus for deep-sea soundings by means of steel wire, with improvements by an American naval officer upon the original plan of Sir William Thomson, deserves special mention, as well as the self-registering deep-sea thermometers of Negretti & Zambra, of London.

Sweden, whose savants have applied themselves with so much success to the exploration of the ocean, had a very complete exhibit of instruments for exploration of the deep-sea fauna and flora, such as dredges, drag-nets, water-bottles, etc.

The instruments of meteorology were very numerous. France, England, and the United States had some fine Fortin barometers, and a rich collection of aneroids, without, however, showing any important novelty. The only barometer constructed on a new principle is that of Mendelieff, of Russia, designed for measuring small differences of elevation with great accuracy. The most remarkable exhibits were those of instruments for meteorological stations, among which those of the Weather-Signal Bureau of the United States Government were the most extensive, comprising, besides instruments for ordinary observation, a complete series of self-registering meteorological instruments.

Two other countries had apparatus for automatic registration equally worthy of consideration. That of Sweden registers and prints, in figures, every quarter-hour, the barometer, temperature, direction, and force of the wind. That of Holland inscribes the observations on a copper-plate, and also registers electrically the indications at different stations at some central point.

Several countries exhibited collections of physical and chemical instruments for purposes of instruction and for laboratories of science. England, France, and the United States were particularly distinguished in this branch, although the exhibit was in no case as large and important as the branch of industry merited, supplying as it does so great a number of schools and colleges. Among the exhibits mentioned were several special ones, remarkable for the merit of scientific invention not less than quality of construction.

Several nations exhibited collections of instruments of this kind, which, judged in an absolute manner, would not have appeared to deserve an award either for novelty or for finish. The group has, nevertheless, given some awards in such cases, because it desired to encourage those who apply themselves to supplying, at low prices, the smaller schools with apparatus adapted for the demonstration of the great laws of Nature. The Province of Ontario, Canada, would have had an award of this kind if it had not declined competition.

CLASS 321.—INDICATING AND REGISTERING APPARATUS OTHER THAN METEOROLOGICAL—MECHANICAL CALCULATION.

The most important exhibits of this class were the two calculating-machines of Mr. George B. Grant, of Cambridge, Massachusetts, the larger one of which is arranged to combine and print functions involving one hundred elements. The combination of the several parts is extremely simple; the number of elements can be indefinitely increased, and the machine acts with the greatest certainty. The smaller machine, or arithmometer, is an adding-machine, which successfully rivals the well-known one of Colmar. The adding-machine of Petersson, of Norway, also deserves special mention here.

Next in importance in this class are water-meters. The growing demand for an instrument of this class which should be cheap enough to be applied to every dwelling, and, with a moderate accuracy, should not be liable to get out of order, has greatly stimulated the invention of water-meters. A great variety of such instruments was presented, the greater number from the United States,—France, Holland, and England each contributing one. It was determined to put these instruments to the test of actual performance under pressure varying from five to eighty pounds. The experiments were arranged in the hydraulic annex of the Machinery Hall, with the kind co-operation of Mr. John Cotter, engineer in charge. Mr. W. F. Blake volunteered the use of his steam-pump, by means of which it was practicable to keep up a uniform pressure of any desired degree, indicated by the pressure-gauge. The Dutch meter proved to be out of order and could not be repaired. The English meter and one or two others gave way under the pressure of eighty pounds. All the rest stood the test to the satisfaction of the Judges and have received awards.

The ingenuity of device in many of these instruments elicited the admiration of the Judges; but it would be invidious to particularize any one here without entering fully into the subject. There are in general two classes of water-meters, one in which the indications are derived from the actual measuring of the volume of water delivered, while in the other class the indications are in some way dependent on the flow of the water. The former, which may be called displacement-meters, are obviously the more accurate form, while the latter are generally of simpler construction, and appear to give sufficiently true results under varying pressures,—the principal object in view, in the general employment of water-meters in a city, being rather to check excessive waste than to obtain a very accurate measure

of the amount used. It is probable that instruments of the latter class will be found best adapted for general introduction into private houses, and the former for large manufactories and hotels.

Ships' logs have been mentioned, as well as hydrographic apparatus, in the previous class.

In gas-meters no special novelty was exhibited.

CLASS 322.—WEIGHTS, MEASURES, WEIGHING AND METEOROLOGICAL APPARATUS.

In measures of length and graduated scales on wood and metal, and graduated tapes of linen or steel, and in tools for gauging casks, the United States alone were represented. Most of the exhibits showed a high order of perfection, being made by machinery expressly devised for the purpose.

In hydrometers and alcoholmeters, the United States Government and that of the Netherlands made important exhibits of instruments used in their several revenue departments. The Judges saw something to commend in a new apparatus for testing the quality of milk, by Tagliabue, of New York, which attempts to arrive at the quality of milk by coagulating and measuring its solid contents. But while this method may be more certain than the areometer, it is perhaps too laborious for ordinary use, and a satisfactory lactometer still remains a desideratum.

Balances and scales occupied a large place in this class. In balances of precision, France was represented by Deleuil, and the United States by Becker & Sons. The instruments of both these houses are of the highest order of excellence. As the circumstances of the Exhibition buildings did not permit their test on the premises, accurate weighings were made with them at the United States Mint, and at the Coast Survey office, in Washington. The accuracy of the Becker balance was shown by numerous tests to be about $\frac{2}{100}$ths of a milligramme when loaded with 400 grammes.

Among balances of precision, the short-armed laboratory balance of T. Sartorius, of Göttingen, Germany, is noteworthy. Some experimenters suppose this to be preferable to the long-armed balance heretofore constructed. The more rapid vibrations of such a balance doubtless afford a certain advantage in rapidity of work; but where extreme precision is required, as in the adjustment of standards, it cannot compete with the balance of Becker or Deleuil.

The exhibit of platform scales for purposes of commerce was very large, France and the United States being the principal competitors. In this branch of industry the United States lead the world in the

adaptation of their scales to various uses and in excellence of construction.

No actual tests of performance were made by the Judges of the various platform scales, inasmuch as the important qualities of permanence of adjustment and of endurance of sensibility could not be tested by any trials that could be instituted on the occasion, while any balance could be easily adjusted as might be required for the occasion.

In this department the house of Fairbanks & Co. are entitled to special mention as having in a great measure originated and largely developed this large branch of industry in the United States, and having, by their various adaptations, greatly facilitated the operations of commerce. In the same branch of manufacture France was very creditably represented by L. Paupier.

A comparatively modern form among weighing-machines is the railway platform scale, of which the conditions are, that it shall always be ready for action and admit of loads as great as forty tons being rolled upon it without injury to its suspension. The construction of these machines is most developed in the United States, and the plan of Riehlé Brothers, of Philadelphia, has appeared to the Judges to offer the greatest guarantee of accuracy and durability. Owing to the great size of these machines, their manufacture in other countries was represented only by models or designs.

CLASS 323.—Chronometric Apparatus.

The Committee on time-keepers made a careful and detailed examination of chronometers, watches, and clocks. Where the claim was for quality of workmanship, they examined all the parts, and where the excellence of the time-keeping properties was involved, actual trials were made. For the detailed results of these trials, as well as a general review of the subject of the state of horology as developed by the Exhibition, the appended report by Professor Watson may be consulted.

OPTICAL INSTRUMENTS.

BY F. A. P. BARNARD, S.T.D., LL.D.

The display of optical apparatus, though not large, was interesting, but contained comparatively little of novelty. Of instruments designed for investigation and research, the number of exhibitors hardly exceeded half a dozen. Among these the most conspicuous place must be assigned of right to Mr. J. Duboscq, of Paris, whose splendid

apparatus for spectroscopic observation, and for researches in physical optics, constituted not only the best, but the only important collection present belonging to these departments of optical science. Of optical glass the displays were very fine, those of Messrs. Chance Brothers & Co., of Birmingham, England, and of Feil, of Paris, leading, as might have been expected from their long-established reputation, all the rest. The disks exhibited by the first mentioned of these firms were largest in diameter; but those of Mr. Feil, of 50 centimetres, were superior in beauty, with scarcely even a microscopic blemish. The specimens of heavy glass exhibited by Mr. Feil were also very remarkable. The specific gravities of these varied between 2.52 and 5.25; and the refracting powers between 1.51 and 1.79. A very interesting collection of artificial gems was also presented by the same exhibitor, the results of a series of investigations in which he has been engaged in recent years, and in which he has succeeded in imitating, to a high degree of perfection, the hardness, the color, the transparency, and the other physical properties of the natural crystals.

The department of optical science most fully represented in the Exhibition was that of microscopy. Even in this, however, we had to regret the absence of some of the most distinguished constructors, among whom may be mentioned Messrs. Spencer and Tolles, of our own country, Messrs. Powell & Leland, of London, and Mr. Hartnack, of Paris. In some of the microscope-stands exhibited, certain minor features of novelty presented themselves, which deserve notice as being real contributions to the facility of manipulation. Such are the plan of fine-movement adjustment embodied in the stand of the Bausch & Lomb Optical Co., of New York, and also the immersion condenser adapted to the same stand. In the new form of stand constructed by Joseph Zentmayer, of Philadelphia, are introduced a number of such minor improvements, which render that stand probably the most convenient in use of any now made, although it is necessarily somewhat expensive.

In the examination of microscope objectives, the Judges had the assistance of some practiced experts not belonging to the Board. So close is the competition at the present time between different constructors, and so difficult are the tests of comparative excellence between objectives of the higher powers, that great care was felt to be necessary in forming and pronouncing opinions. In making the practical tests, the instruments were removed from the Main Building, where they were exhibited, to the gallery of the Judges' Hall, which, from its favorable exposure, furnished a satisfactory illumination. During the trials, the exhibitors themselves, as well as the assisting

experts, were present; and to their courtesy in making every desired arrangement to facilitate the scrutiny the Judges feel themselves greatly indebted. In most instances, after a sufficiently protracted examination of test-objects by the different observers, and a comparison of opinions, judgments were formed without resorting to any corroborative test; but in the case of one or two of the higher powers, photographic impressions of difficult objects were taken by means of the objectives, and the images compared. In this part of the investigation the Judges have to acknowledge the kind assistance courteously lent them by Colonel J. J. Woodward, M.D., of the Army Medical Museum at Washington, in preparing the desired photographs in his physical studio, which is probably more admirably adapted to operations of this kind than any other in the world. It was satisfactory to find that the results of the photographic tests were confirmatory of the judgments which had been previously formed by direct observation.

Among the objectives exhibited were examples of all the varieties of construction employed by the most eminent makers of the present time. The high powers of Dallmeyer are formed of three achromatic combinations, and are designed to work dry; but by the removal of the outer combination and the substitution of a simple front, they are convertible into immersion lenses. The constructor, indeed, appears to entertain very little respect for the immersion principle, and intimates that he has made provision for this transformation only in compliance with a popular fancy; yet his objectives, whether tested by direct observation or by photographic impressions, perform certainly more satisfactorily when used as immersion glasses with the simple front than when working dry.

The high powers of Negretti & Zambra embrace, besides the three achromatic combinations of Dallmeyer, an additional simple front. Some of those of Beck and of Wales consist of only two achromatic combinations with a simple front; while Ross has adopted the construction originated by Mr. Wenham five or six years ago, in which a single achromatic combination is placed between two simple lenses.

Apparently a favorable opportunity was presented by this Exhibition for fairly testing the comparative merits of these several modes of construction; but in point of fact no conclusion which might be drawn from the relative performance of these particular specimens could be justifiably extended to the principles on which they are constructed. Different opticians, indeed, while working on the same plan, do not necessarily grind their curves according to the same formulæ; and even the same artisan employs different formulæ for the same powers at different times. Greater variations, moreover, may

sometimes be found in the performance of objectives constructed upon the same plan, and designed to be identical, than will be detected in comparisons between others in which the principles of construction are entirely different. If we say, therefore, that no better performance was obtained from any of the objectives on exhibition than was given by some of those which consisted of two achromatic combinations and a simple front, it is with no intention of expressing a judgment more favorable to this than to other modes of construction, or of questioning that equal excellence may be obtainable upon the more complex plans of Negretti & Zambra and of Dallmeyer, or upon the simpler plan of Ross. It is to be hoped, indeed, that this simpler plan may yet be found the most advantageous, since thus a reduction in the cost of high-power objectives might reasonably be expected. As yet, however, lenses of this construction have not been offered on terms materially more favorable than those of corresponding power, of which the greater complication and the larger number of elements exact certainly a considerably greater amount of skill and labor to produce them.

Of objects prepared and mounted for microscopic observation a few collections only were exhibited, but these were remarkably excellent. Among them may properly first be mentioned a series of vegetable tissues prepared by Dr. George D. Beatty, of Baltimore, and stained in double colors by a process which originated with himself. Larger collections were shown by Wm. H. Walmsley, of Philadelphia, and Edmund Wheeler, of London, in which the same process had been employed, and which for neatness and delicacy deserve very high commendation.

Lenses, prisms, and mirrors were present in great numbers, and in every variety of form. Among the exhibitors of photographic lenses were embraced the widely-known constructors Ross, Dallmeyer, Voightlander, Derogy, and Busch (the latter represented now by the Rathenow Optical Company). These lenses were only tested by the examination of their certified work. Their reputation, moreover, had long preceded their appearance here. Generally, each exhibitor presented lenses constructed upon different formulæ for different kinds of work. The portrait lenses of Dallmeyer were provided with a useful adjustment for varying the depth of focus, an effect which is accomplished by increasing or diminishing the distance separating the two lenses of the posterior combination.

Of cameras, camera-stands, and other descriptions of apparatus designed to facilitate the mechanical operations of photography, there were many forms possessing merit; but among all these the palm

must be awarded to the Scovill Manufacturing Company, of New York, for elegance, for excellence of workmanship, and for the variety and ingenuity of the expedients employed to promote the convenience of the operator.

A great variety of projection lanterns were exhibited, many of them double, for dissolving views, and one of them triple. These instruments are all similar to one another in their leading features, though differing in minor details. Some of those exhibited embraced the important improvement originally introduced by Prof. Henry Morton, now president of the Stevens Technological Institute, Hoboken, New Jersey, by which the horizontal lantern is convertible into a vertical lantern, for the projection of objects immersed in liquids. The projection lantern has become an almost indispensable part of the apparatus of instruction in nearly every department of human knowledge, and the improvements made in it in recent years, as illustrated in the varieties exhibited, are very great.

Of spectacles, eye-glasses, opera-glasses, and hand-telescopes, monocular and binocular, the exhibitors were very numerous, and many of the articles exhibited were of great merit. In general the constructors of these instruments are not the manufacturers of the material of which their lenses are made. A noticeable exception occurs, however, in the case of Messrs. Willson & Co., of Reading, Pennsylvania, who prepare the disks for their spectacle-lenses by a process of their own, in which each disk is separately moulded under pressure. By this means are secured perfect freedom from striæ and uniformity of density. Among the other exhibitors whose work appeared to be especially meritorious may be named the Bausch & Lomb Optical Co., of New York, the Spencer Optical Manufacturing Co., of New York, and the Spectacle-Makers' Society, of Paris, France.

ACOUSTIC APPARATUS.

In the department of acoustics, as represented in the Exhibition, the field was occupied almost wholly by a single exhibitor, Dr. Rudolph Koenig, of Paris. As a constructor, indeed, Dr. Koenig may be said to have monopolized this field before the world almost as exclusively as in the Exhibition, for it is to his skill that the most eminent investigators have been accustomed continually to resort for the means of realizing their many ingenious conceptions.

The collection of acoustic apparatus exhibited by Dr. Koenig was remarkable, first, for completeness, as embracing every variety of instrumental appliance required for the study of sonorous vibrations, or for the demonstration of the phenomena of sound; and, secondly, for

the scale of unprecedented magnitude on which the principal instruments were constructed. It is gratifying to know that the most important of these, at present entirely unique of their kind, have been secured for one of our prominent educational institutions, where they will be likely to be made serviceable to the progress of American science.

ELECTRICAL APPARATUS.

BY JOSEPH HENRY, LL.D.

A special feature of the Exhibition was the varied applications of electricity to different purposes in the arts, and especially to social economy. We mention first the appliances used for developing electricity.

MAGNETO-ELECTRIC MACHINES.

These are instruments for developing electricity by means of magnetic induction. If a long insulated wire be wound around a cylinder of soft iron and the projecting ends of this cylinder be brought in contact with the poles of a horse-shoe magnet, a current of electricity will be developed, for an instant, in the wire, at the moment of completing the contact. While the cylinder remains in contact with the magnet no current is observed in the wire, but when the former is suddenly pulled off an instantaneous current is evolved in the wire, which has a direction opposite to that of the current induced at the moment of contact. Magneto-electric machines are therefore constructed on the principle of rendering magnetic a core of soft iron, surrounded with insulated wire, and of rapidly reversing its polarity. The first machine for this purpose, which produced sparks, the decomposition of liquids, deflagration of metals, etc., was invented, in 1833, by Joseph Saxton, an American, residing at the time in London. A slight modification of Mr. Saxton's invention was adopted by Clark, an instrument-maker in London, who claimed the invention of the machine as his own, and succeeded in having his name attached to it in works on physics in the French and German languages. Since the invention of Saxton, various improvements have been made on the machine by different persons. Siemens invented an improved rotary armature, in which the insulated wire is wound in the direction of the length of the soft iron core; and which, being made to revolve before the poles of a number of horse-shoe magnets arranged in a row, gave a great increase in the quantity of the induced current.

The greatest improvement, however, was made by an application of the fact that the current induced by a feeble magnet was capable

of inducing, by a rapid revolution of the armature, a much higher degree of magnetism than that of the first inducing magnet itself. This paradoxical result is readily understood when we reflect that every revolution of the armature produces two opposite currents of electricity, which may be reduced to one by a commutator, and that therefore the number of electrical impulses evolved in a given time depends upon the number of revolutions. In the case of a feeble inducing magnet these impulses are also feeble, but by increasing their number the magnetic development in the soft iron core to which they are applied becomes greater than that of the original magnet. The first application of this principle was by Wilde. The machine was, however, improved by Ladd and Wheatstone.

The electro-magnetic machines exhibited at the Centennial Exhibition were those of Gramme, of France, and Farmer, of the United States. The Gramme machine differs from all others of the class in the form of the soft iron core in which the magnetic induction takes place. This core, instead of being a cylinder of soft iron, is a ring formed of a coil of a long piece of iron wire, around which at intervals, transverse to the circumference, are wound a number of coils of insulated copper wire, the ends of which are soldered together into two projecting poles. This ring is made to revolve with great rapidity between the poles of a horse-shoe magnet, in the same plane with them. By this arrangement every point in the ring is magnetized in succession, and a constant current of electricity is produced, of great energy, in one direction. The inducing magnetism may be either a permanent magnet or an electro-magnetic magnet. In the latter case, the machine embodies the principle of increasing the intensity of the inducing magnetism by transmitting around the electro-magnet the induced current. If a machine of this kind with its circuit complete has no residual magnetism in its iron it might be turned at any speed, however rapid, without exciting any electrical current, and, unless the speed exceeds a certain limit, the electrical quiescence is a condition of stable equilibrium, but if the speed exceeds this limit the condition becomes unstable, and an infinitesimal quantity of magnetism would be sufficient to induce a current which, in turn, would be continually increased to an extent only limited by the rapidity of movement. The electro-magnetic machine has important practical applications in the devolopment of electricity for electroplating, electrotyping, for light-house uses and other purposes of intense illumination. The magneto-electrical machine, however, does not transmit and apply power without great loss of original energy. If, for example, it be actuated by combustion derived from coal, only a very small portion

of the energy applied will be reproduced, but this reproduction will be in a form of vastly increased intensity. The machine collects energy, as it were, diffused over a large space, as in the furnace, and concentrates it in a small volume; it receives it at a low temperature, and evolves it at an enormous degree of heat; it receives comparatively dark heat, and transforms it into radiant light of great intensity. Its province, therefore, is the transmutation of energy.

ELECTRIC BATTERIES.

Among the apparatus for producing electricity, galvanic batteries of various forms were exhibited. The most important among these, in regard to novelty and useful effect, was one exhibited by Mr. Byrne, of Brooklyn, New York. This is of the ordinary construction of plates of amalgamated zinc and carbon, and is actuated by the ordinary solution of the bichromate of potassium and sulphuric acid. The novel feature consists of a bellows, by which a stream of bubbles of air ascends through the liquid between the plates and removes the products of polarization from their surfaces. With a battery of this kind, contained in a box six inches square, a wire of platinum of about one-thirtieth of an inch in diameter and eighteen inches in length was brought to a red heat.

A convenient form of what is called Lockwood's Improved Gravity Battery was exhibited by the American District Telegraph Co. In this battery, crystals of sulphate of copper occupy the lower part of a tall glass cell filled with dilute sulphuric acid. In the midst of these the negative plate is immersed, while the zinc element is placed in the upper part of the cell. The crystals of sulphate of copper gradually disappear in the course of a year in the ordinary use of the battery, and an equivalent of sulphate of zinc is uniformly diffused through the upper part of the liquid.

Besides these a variety of instruments were exhibited for applying electricity as a remedial agent. Some of these were ingenious and well adapted to the purpose for which they were intended. It is proper, however, to observe that the Judges do not vouch for the claims set up for these instruments by their inventors as curative agents. If electricity be in some cases beneficial, it will follow that in others it will prove detrimental.

ELECTRO-DYNAMIC ENGINE.

The object of this invention is to produce a motive-power from electro-magnetism applicable to industrial purposes. From the time of its first invention, in 1830, by Prof. Henry, attempts have almost continuously been made to so improve this machine that it might be substi-

tuted for the steam-engine; but all attempts of this kind are necessarily futile, since the evolution of power from the action of acid on zinc is far more expensive than the evolution of an equivalent amount of power from the burning of coal or wood in atmospheric air. The engine, however, may be successfully applied in certain cases in which the expense of power is a secondary consideration, such as, for example, the driving of sewing-machines and giving rapid motion to certain philosophical instruments for experiments in light, electricity, etc. A number of small machines of this kind were exhibited, but they presented nothing important in the way of originality of construction or of application.

SUBMARINE CABLES AND INSULATED WIRES.

Samples of submarine cables were exhibited by the India-Rubber, Gutta-Percha, & Telegraph Works Co., London, by Siemens Bros., London, and by the Telegraph Construction & Maintenance Co., also of London. Of the excellence of one of the cables of the first mentioned of these companies, Sir William Thomson testifies, from personal knowledge, that he found the Direct Spanish Cable perfect after being laid for six months. The specimens exhibited by Messrs. Siemens represent cables which have been laid for the River Platte & Brazil Co. and The Direct United States Cable Co., which are now in operation between Rio Janeiro, Santos, Santa Catarina, Rio Grandé da Sul, and the southern frontier of Brazil and Ireland, and the United States. The specimens of the third-mentioned company represent cables which have been laid by this company in all parts of the world, including the Atlantic Cables of 1865–66; those joining England and France with Malta and Alexandria; the Red Sea and Bombay with England; the cable connecting India with China and Australia; lastly, that connecting Australia and China. The excellence of these cables, as well as those of Siemens, has been tested by Sir William Thomson.

Among the insulated wires, that prepared by Austin G. Day, and denominated kerite insulated conductors, is highly recommended. The wire in this case is covered by an insulator termed kerite, an artificial caoutchouc, in which the raw rubber is replaced by tar or asphaltum, which, combined with animal and vegetable oils, is vulcanized by sulphur.

It may be mentioned in this connection that samples of galvanized telegraphic wire of a superior quality were exhibited by Washburn & Moen, of New York.

We may also place in this class insulating supports. Among those

exhibited, Brook's insulator is mentioned with special commendation. It has great strength, is safe against damage from missiles, and possesses insulating qualities in case of rain, snow, and fogs, superior to any other appliance of the kind known to the Judges.

The British Joint Stock Company for Telegraph Supplies also exhibited a series of insulators of excellent quality for supporting telegraph-wires.

TELEGRAPHS.

The most important applications of electricity were those to telegraphing, fire-alarms, burglar-alarms, and various indicators. The extension and improvements of these applications have been far greater in this country than in any other.

We may first mention Edison's American Automatic Telegraph, which gives, on lines of all lengths insulated on poles in the air, speeds of working which are from two- to tenfold that of any other system hitherto in use. "I have myself, in Philadelphia," said Sir William Thomson, "witnessed the receiving, in fifty-seven seconds, of 1015 words from New York." This telegraph is founded on the principle originally introduced by Bain, that of the chemical action of an electric current on a slip of paper impregnated with a solution of ferrocyanate of potassium. The messages to be transmitted are previously transferred to a series of long slips of paper in which the letters are indicated by perforations representing the dots and spaces of the Morse alphabet. These slips are placed on the circumference of a metallic cylinder connected with the line, and pressed down by a flat spring having a projecting point, which, passing into the holes, completes for an instant the circuit, and thus, by the chemical action of the current, marks the characters on a slip of prepared paper passing over a cylinder at the farther end of the line. The rapidity of the transmission of the prepared messages is scarcely limited by anything else than the rapidity with which the paper can be passed over the surface of the roller. For the rapid stamping of the holes in the paper or preparation of the message for sending, a finger-board with letters on it is used. As a number of persons may be employed at the same time in preparing different parts of a long message, a great amount of intelligence may be transmitted through a single wire in a given time.

DUPLEX TELEGRAPH.

The remarkable invention by which two messages may be sent, at the same time, in different directions, through the same wire, is

claimed by different persons. The first exhibition of this method of telegraphing is referred to Dr. Gintl, Director of State Telegraphs in Vienna. It was, however, much improved by Carl Frieschen, of Hanover, and also, in 1872, by J. B. Stearns and Dr. Farmer, of Boston, Massachusetts.

The conditions necessary to be fulfilled in duplex telegraphing are as follows: The receiving instrument must be so contrived and so connected with the earth and the long line that, while remaining wholly unaffected by the movements of the transmitting key at the home station, it will respond to every movement of the key at the distant station. To produce this effect we may suppose the main line to be charged with two batteries, one at either end, and that the current of each of these batteries is divided into two half currents, one going into the line and the other into a side circuit composed of coils of fine wire, so increased in length as to offer a resistance just equal to that of the line itself. These divided currents are passed through receiving and transmitting instruments furnished with double coils, to transmit the current in opposite directions and thereby neutralize the effect of each battery on its own transmitter, while a slight increase in the power of the battery destroys the equilibrium of the distant receiver and produces the motion necessary to the exhibition of the signal.

A duplex telegraph was exhibited by the Western Union Telegraph Co., of New York, which is commended for the simplicity of the arrangement of the keys and receivers, by which different mes sages may be sent at the same time without liability to error.

THE QUADRUPLEX TELEGRAPH.

The first step toward the invention of the quadruplex telegraph, or that in which four or more messages are sent at the same time through the same wire, was made by Dr. J. B. Starke, of Vienna, in which he sent two messages simultaneously in the same direction, which was a step in advance of the duplex system, since in that the messages were sent simultaneously in opposite directions. This method of sending simultaneous messages in the same direction consists in sending from the transmitting station, by means of two keys, two currents of different intensity, which, at the distant station, set in motion two corresponding relays. This system, combined with that of the duplex, furnished the means of transmitting four messages, two each way simultaneously, through the same wire. In the same way, by sending simultaneously three or more currents, each of different intensity, in the same direction through the same wire, as many dif-

ferent messages may be transmitted at the same time; but when this system is extended beyond the quadruplex the arrangement becomes very complicated, and is consequently liable to derangement and error. Various contributions have been made by different inventors to the practical success of the system, but the improvement to which is principally due its extensive introduction into practice is that of Mr. J. B. Stearns, of Boston, combined with that of Mr. F. A. Edison, of New Jersey. The quadruplex apparatus, in its latest improvement, is now worked by the Western Union Telegraph Co. upon thirty-five circuits, with perfect success. Among other combined circuits that from New York to Chicago, a distance of one thousand miles, had been working for several weeks without interruption, giving simultaneous communications, at full speed, with an average daily work exceeding fifteen hundred messages. The details of this system are too complex to give any idea of them in an explanation of this kind, and without diagrams. We refer, however, for the best account hitherto published of this and all other telegraphs and their applications, to a work by George B. Prescott, electrician of the Western Union Telegraph Co., published by D. Appleton & Co., New York.

AUTOGRAPHIC OR COPYING TELEGRAPH.

The autographic or copying telegraph, which gives a fac-simile of the original written message, requires no skilled labor in the transmission of dispatches, the original copy being prepared by the sender and the received copy being in a condition for immediate delivery. It has, however, never been employed to any considerable extent in the transmission of messages, because the rate of profitable work has been too slow. It has lately, however, been employed in transmitting the lines of equal barometrical pressure for the use of the Meteorological Signal Office of the United States army. The process consists in writing or drawing, on silvered paper prepared for the purpose, the message or diagram to be transmitted, in a bold hand, with a fluid which, when dried, is a non-conductor of electricity. The metallic paper thus prepared is attached to the circumference of a metallic cylinder connected with the line, which revolves synchronously with another cylinder at the farther end of the line, around which is a sheet of ordinary paper imbued with the ferrocyanate of potassium. Both cylinders have, besides a rotary motion, a lateral one, given them by a screw on the axis. The current from the battery is transmitted to the metallic paper, and by it to the line, from a point or stylus, and as the two cylinders revolve a line is marked on the distant one with a break in it at the point corresponding to that at which the point of the stylus

passes over the writing or drawing on the silvered paper attached to the first cylinder. A series of these lines, like those produced by a ruling-machine, covers the whole paper, with the exception of the lines of writing or drawing, which are thus exhibited by contrast on the surface of the prepared paper. The impression may be reversed, and the writing shown in a darker hue than that of the ordinary color of the paper. The latest improvement on this process is that by W. E. Sawyer, of Washington, D. C. This consists in writing the original message on ordinary writing-paper, with common ink containing a little glycerin to prevent drying too rapidly; the writing is then dusted with powdered shellac and laid face downward upon a plate of clean zinc. The plate and paper are next passed between heated rollers, by which a reversed copy of the writing is transferred to the zinc plate in non-conducting lines. This metallic plate is finally bent around the cylinder attached to the line, in place of the silvered paper previously mentioned.

THE ELECTRIC TELEPHONE AND MULTIPLE TELEGRAPH.

The idea of transmitting sounds to a distance by means of electrical currents has been for several years before the world, and the idea of extension of this to telegraphy was evident, though no one had thought it could lead to practical results. But the idea of a multiple electrophonic telegraph transmitting simultaneously several different musical notes for the simultaneous transmission of different messages by one wire, is an invention of high scientific character promising admirable practical results. For the honor of this invention there are two claimants, Mr. Elisha Gray, of Chicago, Illinois, and Mr. Alexander G. Bell, of Salem, Massachusetts. These inventions are independent of one another and different in the method of producing the result. In the telegraph of Mr. Gray several series of waves or impulses are simultaneously transmitted through a single wire. These impulses are excited by interruptions in the current produced by tuning-forks of different pitches, and excite, at the farther extremity of the line, corresponding variations in tuning-forks of the same pitch. Thus, if four or five tuning-forks are vibrated at the same time at one end of a line, each will excite vibrations in its corresponding fork at the other end without affecting the other forks. The exhibitors of this telegraph inform the Judges that they are now able to equip lines for actual business with a capacity for carrying, through one wire, eight messages simultaneously, and there is no reason why the number may not be increased to sixteen. This telegraph may be made self-record-

ing, or may be worked forward by relays through greater lengths of line than the insulation allows in one circuit.

The telephone of Mr. Bell aims at a still more remarkable result, —that of transmitting audible speech through long telegraphic lines. In the improved instrument the result is produced with striking effect, without the employment of an electrical current other than that produced by the mechanical action of the impulse of the breath as it issues from the lungs in producing articulate sounds. To understand this wonderful result, suppose a plate of sheet-iron, about five inches square, suspended vertically before the mouth of the speaker so as to vibrate freely by the motion of the air due to the speech, and suppose also another iron plate, of the like dimensions, similarly suspended before the ear of the hearer of the sound, and between these, but not in contact with them, is stretched the long telegraphic wire. Each end of this wire is attached to two coils of insulated wire surrounding a core of soft iron, the ends of which are placed near the middle of the plate, but not in contact with it. These four cores are kept in a magnetic condition by being attached at each end of the line to the two poles of a permanent magnet. Now it is evident that in this arrangement any disturbance of the magnetism of one of the permanent magnets increasing or diminishing it will induce electrical currents, which, traversing the long wire, will produce a similar disturbance of the magnetism of the arrangement at the other end of the wire. Such a disturbance will be produced by the vibration of the plate of soft iron due to the words of the speaker, and the current thus produced, changing the magnetism of the soft iron cores, will by reaction produce corresponding vibrations in the iron plate suspended before the ear of the hearer. The vibrations of the second plate being similar to those of the first will reproduce the same sounds. Audible speech has, in this way, been transmitted to a distance of three hundred miles, perfectly intelligible to those who have become accustomed to the peculiarities of certain of the sounds. All parts of a tune are transmitted with great distinctness and with magical effect.

This telephone was exhibited in operation at the Centennial Exhibition, and was considered by the Judges the greatest marvel hitherto achieved by the telegraph. The invention is yet in its infancy, and is susceptible of great improvements.

THE PRINTING TELEGRAPH.

This telegraph, which sends messages in the ordinary letters of the alphabet, was invented in 1846 by R. E. House, of Vermont, but has

since been improved by David E. Hughes, of Kentucky, and by George M. Phelps, of Troy, New York. The objection to this mode of telegraphing has been the slowness of the operation. In the most improved instruments of this system of telegraphing, however,—those of Phelps,—sixty words have been transmitted in a minute. A printing telegraph instrument, by Anders, of Boston, very well adapted for private use between places of business and dwelling-houses, was reported favorably upon at the Centennial Exhibition. It is of simple construction, and little liable to get out of order; no voltaic battery is used, the signals being transmitted by magneto-electric action. Another printing telegraph for similar purposes was exhibited by Gray, of Chicago. It differs from the preceding instrument principally by being actuated by a gravity battery of eleven small cells for a line of forty miles, and four similar local batteries for each receiving station. A third instrument of this class was by Phelps & Philips, of Philadelphia. It embodies, in a compact form, a receiving apparatus to indicate by letters on a dial, a transmitting apparatus with a key adapted to the same, and also a call-bell. It operates rapidly and efficiently, does not require an experienced operator, and is well adapted to general use.

BURGLAR-ALARM AND AUTOMATIC ANNUNCIATORS.

The object of this form of telegraph is by a series of wires, connected with the outer doors and windows of a house, to give intelligence in a sleeping-chamber of any opening of these apertures at an unusual hour. The arrangement is such that the number of strokes on a bell specifies the exact place of disturbance. Another feature of the arrangement is such that an indicator points out the fact as to whether all the windows and doors of a house are closed.

One of these instruments was exhibited by George A. Dowden, of Newark, New Jersey, and another by the Burglar-Alarm Telegraph Co., of New York. The latter was specially applied to bank-safes with a peculiar and effective arrangement, which, by double panels, with sheets of tin-foil between, closing an electrical circuit when the panel of the door is pierced, or broken, or cut into, gives the alarm.

AUTOMATIC FIRE ANNUNCIATOR.

In this, two metals of different expansibility make a contact when heated to a certain degree, by which an electrical current is put in motion and a bell rung. The arrangement is very simple and much less liable to get out of order than that in which a circuit is closed

by means of the expansion of mercury heated in a glass tube with a bulb.

ELECTRICAL ANNUNCIATOR.

The object of this telegraph is to send messages from the chambers of a hotel to the office. In the annunciator exhibited by Watts & Co., of Baltimore, nine separate calls may be made, for as many different articles, by touching the respective buttons opposite to which the different messages are written.

FIRE-ALARM TELEGRAPH.

The object of this telegraph, as the name indicates, is to receive at a central office intelligence of a fire in any part of a city, and from the office to give an alarm to the various fire companies by striking the church-bells in accordance with an adopted system of associated sounds and intervals of silence. It was originally invented by Moses G. Farmer, of Boston, in 1857, and now, with many improvements and developments, is used in seventy-eight cities in the United States and Canada. The alarm, from a place near the fire, is transmitted to the central office from a small magneto-electric apparatus, inclosed in a box permanently attached to a wall in some accessible place, which, by turning an exterior crank, sends an induced current to the central office, which calls the attention of the attendant by ringing a bell. The church-bell is struck by the motive-power of a descending weight or by that of the city water-works. The power is brought into operation by the attraction of the armature of a relay magnet, which, by removing a detent, enables the power to act. This telegraph was exhibited by J. N. Gamewell & Co., of New York.

Another fire-alarm telegraph was exhibited by the National Fire-Alarm Co., of Richmond, Indiana, and was commended for good design and construction.

RAILWAY SIGNALS.

Another invention under this general class is intended to give information at the terminus of a railway as to the position of cars on the road at a given time, or of accidents, as the case may be, by an electrical circuit through the rails of the road and the axle of the carriage. An award was recommended for this invention on account of the usefulness of the object proposed and the promise of practical success which the details of the method justify.

MAGNETS.

A magnificent magnet, constructed on the plan of M. Jamin, was exhibited, carrying a weight of 450 kilogrammes, or about four times its own weight. This magnet was constructed of plates of steel of the form of a horse-shoe magnet with elongated limbs. This form of the magnet is the result of a series of experiments by M. Jamin, of Paris, on the distribution of magnetism in plates of hardened steel. For determining this distribution he employed a small soft iron cylinder or pencil, surrounded by a coil of insulated wire, the ends of which were attached to a galvanometer. When the rounded end of this cylinder was applied to a point on the surface of the magnetized plate and then suddenly withdrawn, the deflection of the needle of the galvanometer, due to the electrical current induced in the wire, measured the relative intensity of the points touched. From the investigations thus made the following conclusions were deduced:

First. The quantity of magnetism that can be contained in a magnet does not alone depend upon the average section.

Second. The distribution of the magnetism is regulated by the form and extent of the exterior surface.

Third. If the surface diminishes, the tension augments up to a certain point, after which it diminishes.

Fourth. If the surface changes but the mean section remains constant, the quantity of magnetism also remains constant.

Having established the fact that the mean section determines the quantity of the magnetism, and that the surface is that which regulates the distribution, it follows that if the magnet is made greater without increasing the quantity of magnetism the tension becomes less. In accordance with these laws it was found that when magnetized plates were placed upon each other, the magnetism of the surfaces of contact was diminished while that of the exterior was increased up to a certain limit, which depended upon the length of the plate. The power of the plate increases considerably with its thickness, but less rapidly than the thickness, so that there is a limit beyond which it remains stationary. But a plate of a given thickness has less power than two others each of half the thickness. M. Jamin was thus enabled, by employing ribbons of steel, to construct magnets carrying twenty times their own weight.

MAGNETIC COMPASS.

Abundant evidence has been afforded of the value of the improvements on this instrument, of essential use in navigation, in the float-

ing compass of E. S. Ritchie & Sons, of Boston. The card of this compass is furnished with two magnets placed parallel to each other, the ends sixty degrees apart, on opposite sides of the meridian line. The whole is floated in a liquid not susceptible of freezing, the buoyancy of which lessens the pressure on the point of support and gives shortness of period to oscillations, thus furnishing stability in pointing out the magnetic meridian. The instrument is also commended for the perfection of its centering and accuracy of division. It is adopted for general use in the United States navy.

Ritchie & Sons also exhibited an improvement in the marine azimuth compass for use in iron ships. By means of a reflector the observer looks downward towards the compass bowl, in taking a bearing by this instrument, and thus obtains the great advantage of seeing the numbers of degrees on the compass-card direct, instead of inverted as in the ordinary prism-compass, while it secures the further advantage of permitting the application of the mass of soft iron required in correcting the quadrantal error of the compass without impeding the use of the instrument in taking azimuths in any direction.

Another nautical compass, exhibited by the Brazilian navy, is favorably noticed. It is an azimuth compass with a repeating movement giving the means of increased accuracy of results.

APPARATUS FOR CORRECTING SHIPS' COMPASSES.

This apparatus devised by Prof. B. F. Green, of the Navy Department, and which is denominated an adjustable binnacle, is intended first to serve as a convenient receptacle of a compass on shipboard, with the usual provision for protection and illumination; second, to furnish magnetic correctors, with arrangements for their convenient adjustment, so as to neutralize the magnetic force of the ship. This apparatus supplies a complete solution of the problem of the correction of compasses on iron ships, and has contributed much to the improvement of compass-correction on ships in the United States navy.

It may be mentioned, in connection with this subject, that it is now tolerably well ascertained that some of the sudden and hitherto unaccountable deviations of the compass on board of iron ships are caused by the unequal and varying diffusion of heat over the iron hull. This is a true cause of variation, and though small in ordinary cases, would probably produce effects of considerable magnitude in passing, for example, from the Gulf Stream into a polar current.

MISCELLANEOUS INVENTIONS.

Among these one of the most interesting is that of the Electrical Pen and Duplicating Press by T. A. Edison, of New York. This application of electricity is intended to produce an indefinite number of copies of manuscript or drawings. This is effected by causing a fine steel needle to be projected from the point of a tracing-pen, by which the impression on the original paper is represented in a copy by a continuous series of perforations. The motion of the needle is produced by a small electro-magnetic machine held in the hand. The copies are taken by placing under the perforated paper a blank sheet, and passing over the former a cylinder imbued with printers' ink.

THE PNEUMATIC TELEGRAPH.

Three samples of this invention were exhibited, one by Walcker, of Paris, another by Kuntz & Co., of Stockholm, and a third by Zimber & Turtwangen, of Germany. This form of telegraph is simple and useful for transmitting a small power to a distance, for the purpose of signaling and other objects. It consists essentially of a long tube of india-rubber, lead, or tinned iron, with an elastic rubber bottle at one end and a cylindrical bellows at the other. When the bottle is compressed in the hand, an impulse is transmitted through the air to the other end of the tube, which, by expanding the bellows, moves a ratchet, giving motion to a wheel, which in turn moves the hammer of a bell, or produces other mechanical effects.

LIGHTNING-RODS.

A great variety of these were exhibited, but with one exception they were not in strict conformity with well-established principles of electrical science. The one recommended for award as being in accordance with all the established facts of electricity, was by D. Carrette Dobels, of Belgium. It consisted of a principal rod of wrought iron, which metal is a sufficiently good conductor for electricity of high tension, is cheaper than copper, and is not liable to be melted, as the latter is, by a heavy discharge of lightning. The rod is cylindrical, which form, being free from salient edges, is the best for transmitting a discharge without danger of lateral diversion. The part of the rod which is elevated above the roof is slightly tapering, to present less resistance to the wind, and the rod is covered with a coating of metallic paint, which prevents rusting, and does not interfere with the transmitting power of the conductor. It is terminated

above by a single platinum point, which, from theory as well as direct experiment, is known to produce a greater effect in directing the path of a discharge than several points terminating the same rod. To insure a good connection with the earth, the rod is terminated below in five branches projecting into moist earth or water. We would only add to these peculiarities that an essential feature of a good lightning-rod is its intimate connection with the earth, and to make this as perfect as possible its lower end should be put in metallic connection with the water- or gas-mains of a city.

ELECTRICAL MEASURING INSTRUMENTS.

Among these were a variety of Galvanometers and Resistance-Coils which are commended for the excellency of their workmanship, though they involve no new principles.

MUSICAL INSTRUMENTS.

BY HENRY K. OLIVER.

Before entering upon detailed statements as to the various musical instruments shown at the Centennial Exhibition, it may be desirable to sketch the rise and progress of their manufacture in the United States. The subject is difficult because of the scant supply of records and of historic material. With that unsatisfactory aid, and by means of traditions and reminiscences contributed by those yet living who were early engaged in the trade, the subjoined helps to more exact history are given.

PIANO-FORTE.

This instrument, with the organ, is rightly characterized as a beautiful example of ingenuity and of skill in achieving success over all complexities of leverage between key, wire, and pipe; of most delicate mechanism in action; and of resonant power, and tonal richness in result. Though ranking above all other instruments of music in its varied social relations and influences, the origin and early and continuous history of the piano-forte are not free from obscurity, nor without controversy. Research and observation trace its leading principle, that of stretched strings, to the ancient lyre and harp. The general position and lay of the strings, in all classes of the instrument, clearly indicate this origin and relationship, the prototype harp assuming, along the line of centuries, the several forms of psaltery, dulcimer, clavicitherium, clavichord, virginal, spinet, and harpsichord,—ripening, after the lapse of more than 2000 years, into the perfectness of the

magnificent instruments of modern times, with their better materials, more exact appliances, finer adjustments, greater strength of parts, increase of compass and power, elastic responsiveness of touch, enlarged sonority, and satisfying delicacy and singing character in tone. What success has crowned these efforts is well evidenced in the splendid instruments of Broadwood and the Collards, of London; Erard, of Paris; Bechstein, of Berlin; Chickering, of Boston; Steinway, Decker, and Weber, of New York; and Knabe, of Baltimore.

By whom the first piano-forte was made in the United States is an interesting inquiry. The earliest instruments in use were invariably imported. Bishop, in his *History of American Manufactures* (Philadelphia, 1864), says that "the piano-forte, superseding the harpsichord, appears to have been first made in Philadelphia, by John Belmont, in 1775," adding that "in 1785, James Julian, of the same city, announced a piano-forte of his own invention," and that "in 1790, the *Advertiser*, a newspaper of Philadelphia, says 'an ingenious artist here has completed several piano-fortes, not inferior to those imported.'"

About the same date (1785), Benjamin Crehore, of Milton, Massachusetts, a manufacturer of violoncellos, guitars, etc., succeeded in manufacturing piano-fortes, copying, probably, from Broadwood, whose instruments were then occasionally found in wealthy families in Boston.

The first piano-fortes made in Boston were the work of Adam and William Bent, about the year 1803, though harpsichords and spinets were made in Salem, Massachusetts, prior to 1795 (the year of his death), by Samuel Blythe. One of his instruments is now in the possession of the Essex Institute, of that city, on the front board of which one reads, "Samuel Blythe fecit" (no date). The instrument is about five feet in length and thirty inches in width, its key-board having five octaves.

In 1800, John J. Harkins, of Philadelphia, patented an improvement in the piano-forte, which instrument he manufactured and sold in that city under the name of "Patent Portable Grand Piano."

We next find Lewis and Alpheus Babcock, apprentices of Crehore, manufacturing piano-fortes in Boston. In 1810, they entered into partnership with Thomas Appleton (afterwards a celebrated organ-builder), and the brothers Hayts, Babcocks, and Appleton, Crehore, then an old man, working for them, with John Osborne as an apprentice, who, about 1814, set up in business for himself. This firm, crippled by the war with England (1812–15), dissolved in 1820, the Hayts moving to Buffalo, New York; Mr. Appleton devoting his skill to organ-build-

ing; and Mr. Alpheus Babcock, with the aid of John Mackay, who had invested capital in the old firm, continuing the piano-forte business in the Parkman Market building, on Cambridge Street. Within a couple of years Babcock removed to Philadelphia, continuing the business there with a German associate.

Between the years 1810–15, Robert Cowan, an ingenious Scotch mechanic, resident in Salem, Massachusetts, made several piano-fortes in that city, which the writer of this article saw and played upon at Cowan's factory as late as 1822.

In 1810, Adam Stewart, a Scotchman by birth and a piano-forte-maker by trade, emigrated to this country from London, where he had learned the business in the house of Clementi. He settled in Baltimore, where, with the aid of his brother, James Stewart, he made several instruments. A few years later, Osborne, becoming acquainted with James Stewart, induced him to remove to Boston. With them Timothy Gilbert and Jonas Chickering, the latter of whom afterwards achieved a wide and most deserved celebrity, were apprentices. Osborne and Stewart parting, the new firm of Stewart & Chickering was established, February, 1823,* in a building next east of King's Chapel Burying-Ground, on Tremont Street. In 1827 Stewart returned to England, joining the house of Clementi & Co., and Chickering continued alone till 1830, when the firm of Chickering & Mackay was created, continuing till 1841, when it was dissolved by the death of Captain Mackay, who was lost at sea, and Mr. Chickering conducted the business alone. Entering upon a career of successful enterprise, he gave an unprecedented impetus to the trade, and, creating a widely-spread demand for its products, allured capital and skill, awakened an exciting and effective rivalry, provoked many and important improvements, and inseparably interwove his name into the history of this great branch of mechanic skill.

Following the lead thus begun came a long line of manufacturers, more or less successful. Among the former were Timothy Gilbert, E. R. Currier, Brown & Hallett, Hallett & Cumston, George Hews (honored for his skill and loved for his virtues), the Woodwards, and Hallett & Davis, the latter of whom has passed a half-century in the business. To these should be added Albert W. Ladd, of whose instrument at the International Exhibition (1855), with its "over-strung bass" wires (claimed by Mr. Ladd as his invention in 1853), M. Fétis spoke in terms of high praise, as remarkable for its power and equality of tone.

* An instrument made by Chickering in 1823, and in excellent order, was on exhibition at the stand of Chickering & Sons in the Main Building during the Exhibition.

In New York, nearly all the piano-fortes up to the year 1820 were square, imported from England by John Jacob Astor, being from the manufactory of Broadwood or of Clementi. These were to be found only in the homes of very wealthy citizens. But in that year several expert and skillful foreign artisans immigrated, and established factories in that city, among them being Geib, who was also, we believe, an organ-builder, Robert and William Nunns, Adam Stodart, J. B. Dunham, Horatio Worcester, and Bacon & Raven. These became well-known and extensive manufacturers, occupying nearly the whole trade, and rearing many well-trained artisans. As a general rule, the New York makers were unfavorable to the use of the iron frame, believing it not promotive of purity and clearness of tone. None of the more prominent among them made any attempt at its introduction into their instruments.

Henry Steinway, the founder in New York, in 1853, of the house of Steinway & Sons, emigrated in 1850 from the Duchy of Brunswick, where he was born in 1797. He brought with him four sons, he and they at first working at their trade of piano-forte-making with different manufacturers. Commencing with prudent caution, and gradually, as success justified, enlarging their facilities, they, in 1855, entered upon a very extensive line of business, expanding yearly to wider and wider dimensions, enrolling themselves among the great manufacturers, and achieving an eminent and widely-recognized celebrity. There was also, in the same city, an increasing number of manufacturers of note, who, by persistent industry and skill, achieved reputation and success, so that now New York supplies a very large demand by an array of instruments of well-merited character for excellence in workmanship and in all the qualities that constitute a thoroughly good article.

In Philadelphia, between 1819 (when the business seems first to have taken firm root) and 1825, the prominent names appear to have been James Taws, C. Pommer, John Loud, C. F. L. Albrecht, Conrad Meyer, yet living, and Bassert & Schomacker. Since that date are recorded the names of John and Thomas Loud, Fred. W. and C. Pommer, Schomacker, the Schomacker Manufacturing Company, the Albrechts, and Conrad Meyer & Sons. Conrad Meyer, the founder of the latter house, was born in Hesse-Cassel in 1793. He immigrated to Baltimore in 1819, commencing his business at once of a piano-forte maker. In 1823 he removed to Philadelphia, and has since continued there, associated with his sons, he himself being now (1876) the oldest living manufacturer in the United States.

As early as the year 1810 this branch of manufactures appeared

in Baltimore, Adam Stewart, a Scotchman, and a piano-forte-maker by trade, having at that date begun business on a small scale. In the year following, his brother, James Stewart, of the same trade, also settled in that city. In 1812 the brothers joined in partnership, and turned out several instruments, one of which is now extant. James Stewart afterwards, in 1819, joined John Osborne in Boston, the latter having bought out the stock and fixtures in Baltimore, the war with England (1812–15) breaking up their business.

There appears also to have been in that city in the year 1819 another establishment, carried on by William Hartge, in which appeared, about the year 1830, Mr. William Knabe, an immigrant from the Duchy of Saxe-Weimar, Germany (now deceased), who learned his trade in Gotha. In 1837 he founded the existing house of William Knabe & Co., which has built up a deservedly successful business of the largest dimensions, involving a capital of half a million of dollars and employing about four hundred artisans. Their instruments hold a high rank and supply a large demand.

Between 1825—when iron began to be used as a resistant to the pull of the strings and a strengthener of the wooden frames in general use—and the present day, many important improvements, originating with ingenious manufacturers in both America and Europe, have been made in nearly every part of this instrument, so that in the modern grands, squares, and uprights one can hardly recognize the prototype of the early years of the century. Among the most valuable of these improvements are the iron frame, the circular scale, the over-stringing (claimed by several manufacturers as original with them), the increased size, strength, and solidity of the instrument and of its strings, with their greater sonority, brilliancy, and carrying power, yet without sacrifice of richness, purity, delicacy, and singing quality, and the securing of an almost perfect responsive elasticity of touch. To these may be added the greatly increased compass of the instrument from the five octaves of 1800 to the seven and one-third of the present day.

The piano-forte has now its three distinct forms of grand (subdivided into concert- and parlor-grand), square, and upright; the square being the most common form in the United States, and the upright in Europe, as it will doubtless be here, its compact shape, its capabilities and powers, as well as its facility for transportation, aiding its more extensive adoption. The old objections to the upright piano-forte, on the score of weakness in construction and uncertainty in keeping in tune, have been obviated by modern skill and improvements; and it is rapidly gaining favor.

At the Centennial Exhibition at Philadelphia there were presented, by upwards of sixty manufacturers, about two hundred piano-fortes of the four varieties of concert-grands, parlor-grands, squares, and uprights. Most of these were of American production, some few from the British provinces, and some from Europe. Taken as a whole, the collection was entitled to the very highest praise, while of many of them it would be difficult to speak in adequate terms of commendation, and difficult too to distinguish between the best of the best makers; and while there were many very excellent instruments among those presented by foreign exhibitors, we feel fully warranted in saying that, for superior quality in tone, impartial evenness in distribution of power along the whole scale, sharply responsive elasticity of touch, fidelity and taste in workmanship, with normal excellence in materials employed, and valuable practical improvements in great variety, the American exhibit presented instruments responding in all particulars to every requirement that can be made of this department of art.

Of foreign exhibitors, there were from Germany, 10; England, 4; British Provinces, 7; France, 3; Russia, 2; Spain, 1; Switzerland, 2; Sweden, 1; Brazil, 1; Australia, 1,—total, 32; and the American being 32, gave a full total of 64 exhibitors of piano-fortes alone, the number of instruments being upwards of 200.

Of church-organs there were 6 exhibitors; of parlor-organs 12; and a very large number in the departments of instruments for orchestras and military bands. These exhibits were all displayed in various parts of the Main Building, where it was manifest that no proper testing could be made, both crowd and noise preventing. It may be here stated that the subject of the musical instruments, string, wind, and pulsatile, was assigned to the Judges of Group XXV., consisting of ten members, to four of whom, Julius Schiedmeyer, of Stuttgart, Germany, a manufacturer of piano-fortes and harmoniums, with experience as a Judge at Expositions in Europe; George F. Bristow, Professor of Music, of New York; F. P. Kupka, of Vienna; and Henry K. Oliver, of Massachusetts,—the last two being amateurs,—the immediate examination and testing were deputed.

The duties devolving upon these four, of whom only two were constantly on duty, were exceptionally arduous, demanding versatility and variety of experience in the several departments, and severely taxing brain and body. It was suggested that their numbers be increased. It being, however, too late, authority was given to employ

experts when deemed advisable or necessary. This was done with orchestral and band instruments only.

At their meetings for organization and arrangements it was decided, in relation to all instruments (excepting church-organs), 1st, that the testing should be made in the hall of the Judges' Pavilion; 2d, that the several exhibitors might select, each from his whole exhibit, such instruments, not exceeding one of each variety, as he was willing to present for judgment; 3d, that each exhibitor should be invited, prior to the testing of his instruments, to make such statements to the Judges as he desired, in reference to his claims, and to the qualities of his instruments; 4th, that a figurate scale should be adopted in determining the qualities of piano-fortes, descending from six downward, according to their degrees of excellence in tone, evenness of distribution of power along the scale, or equality, general quality as a whole, and elasticity of touch; and that practical valuable improvements and workmanship, neither of which could be numerically expressed, should receive careful consideration in making up awards; 5th, that all piano-fortes, the average of whose several markings should amount to three or upwards, should be recommended for awards. But one objection appeared against this method, a very serious one indeed, which, however, it was believed a sense of honor and justice would obviate. It permitted a partisan Judge, should there be one, to practice favoritism by marking high or low, as the exigencies of an object to be accomplished might prompt. This general method being determined, the testing took place, all the instruments, excepting the church-organs, being brought to the Judges' Hall. The church-organs were examined at their several locations in the Main Building, after the retiring of the crowd.

The method of award adopted by the Centennial Commission, of recognizing merit wherever found, whether in "originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purpose intended, adaptation to public wants, economy, and cost," opened a very wide door, and led to a liberal distribution of awards. It must be borne in mind that the Judges themselves had no power to make these awards, their only function being, after proper testing and examination, to "*recommend to the Centennial Commission for award*" whatever exhibits might, by such Judges, be deemed worthy thereof.

An instrument of complicate action, called a violin-piano, in the shape of a grand piano-forte, was exhibited by George Greiner, of Sacramento, California. It was an attempt to produce from the wires the tonal effects and continuity of tone of instruments of the violin

class. The same experiment has been before not successfully attempted, both in England and in France. At the Paris Exhibition of 1867, M. Baudet, a Frenchman, exhibited a similar instrument; but every attempt of this sort since the seventeenth century has failed, the upper part of the strings giving the tone of the hurdy-gurdy, and not of the violin; the middle strings giving those of the harmonium; and the lower, and by far the most pleasing, giving some semblance to the tones of the violoncello, yet not so fully characteristic as to deceive the listener. The instrument in question received a great deal of attention from the Judges, and afterwards, on appeal of the exhibitor, was re-examined by the proper Judge on appeals, and by five experts, with entire unity of adverse opinion. What may be the result of continued effort in a field of doubtful promise or utility it is not possible to predict.

There was another piano-forte, exhibited by Achille Perise, of Italy, with a very ingenious apparatus connected with its keys, by which improvisations of any pianist may be recorded, as he plays them, on paper adapted to the purpose, and then transferred by copying upon ordinary music-paper.

M. Thibouville y Lamy, also, of Paris, exhibited a mechanical apparatus of much ingenuity, called a pianista, which can be applied to organs or pianos. It is an instrument with a key-board adaptable to that of a piano or organ. Its function is to play on these instruments mechanically, by means of perforated cardboard, and it executed music in great variety with entire exactness and much expression. The mechanism of the pianista is very solid, and the manner of using the instrument exceedingly simple, the book of perforated cardboard representing the piece of music to be played having only to be placed on top of the pianista, already adjusted to any piano-forte, and then, by the turning of its handle, the cardboard is put in motion, performing the music, and requiring no guiding, but forming itself into a book again as it moves along. It is the most ingenious and perfect piece of mechanism yet invented for playing pianos and organs automatically.

The oldest piano-forte on exhibition was that of Johannes Christian Schreiber, made in 1741.

Very excellent piano-fortes and parlor-organs were also exhibited by Julius Schiedmeyer, of Stuttgart; but no award was made, as he himself was one of the Judges on musical instruments.

The result of the test of the piano-fortes was, that of the whole number presented for trial, taking the average of the numbers given on the points before named, there stood the test 23 grands (12 con-

cert and 11 parlor) out of the 31 tested, or about 74 per cent.; 25 uprights out of 28, or about 90 per cent.; and 28 squares out of 39, or about 72 per cent. These percentages clearly indicate the increasing success following the increased attention given to the manufacture of grands and uprights, especially the latter, as compared with squares. Comparing, also, the whole number that stood the test with the whole number tested, it appeared that 76 out of 98, or 77½ per cent., were successful. Among them are included both foreign and home-made instruments, those tested being selected by the several makers from their own several exhibits.

ORGAN.

This noble instrument, king in the realm of music, complicate as it now is, yet of easy control under the hands of experts, fertile in varied symphonious effects, giving with equal and satisfying success the gentlest and most sympathetic tones, as well as complete and sublimely-full utterances of musical inspiration, has a remote and continuous history, into the minute details of which it is not necessary here to enter, except so far as the manufacture of the instrument in the United States is concerned. Originating in rude form, in the earliest Christian centuries, it is referred to in a Greek epigram of the fourth century as "with reeds of a new species agitated by blasts of wind that rush from a leathern cavern beneath their roots, while a robust mortal, running with swift fingers over the concordant keys, makes them smoothly dance and emit harmonious sounds." "The Hydraulicôn," or "water-pipe organ," into which, by some unknown method, the air was introduced by water-pressure, gave way in the sixth century to the wind-organ. This, with "its loud sounds produced from divers pipes," had movements made of wood, which, "pressed down by the fingers of the player, produce the most pleasing and brilliant tones." This not very lucid description evidently points to the organ in its elemental state. In the seventh century it found its way into the church, and, becoming known in Western Europe, grew rapidly into favor and general church use, though having but few pipes and fewer keys, and requiring the united work of several men that

"all the wind be pressed
In the close confines of the incumbent chest."

It is matter of wonder that an instrument whose extraordinary capabilities have been so completely developed within the last few centuries should have remained thus long in so imperfect a condition. Even in the twelfth century its compass did not extend beyond two

octaves, half-notes being then first introduced; nor were registers, without which no variety of stops could be secured, introduced till the seventeenth century. Pedals had, however, been introduced before that period. From the Reformation to the reign of Charles I. but little mention of this instrument was made in England. During his reign prejudice ran so strongly against the use of any instruments as aids in church music that nearly all the organs in the kingdom were destroyed, and organists driven to other employments for support, a deep-seated hatred by the Puritans for all forms of worship of the Established Church running to such extremes that Government was petitioned "to put down all cathedral churches, with their piping of organs, ringing of chime-bells, and squeaking of chanting boys." At the Restoration a change took place; but, as expert organ-builders were not to be had in England, foreign artisans were summoned, the most celebrated being Bernard Schmidt, who restored the art and supplied many skilled workmen. This spirit of opposition came with the early settlers of New England, whose inveterate and persistent opposition to its use in public worship extended to a period within the memory of many now living, with the singular inconsistency of permitting the use, in public praise-service, of contrabassos, violoncellos, bassoons, clarionets, and even violins. In 1810 there were in the city of Boston, then containing about 30,000 people, but five organs in the churches, and in 1817 there were but eight, a gain of only three in seven years. The clergymen of the olden times had grave doubts whether instrumental music could "without profanity be introduced into the churches of New England for the worship of God." It is known that Thomas Brattle, of Cambridge, Massachusetts, in his will (1713) bequeathed his organ (probably a parlor-organ) to the Brattle Street Church, in Boston, "if said church would accept thereof." But the church refused to do so, and the organ went, as provided in case of such refusal, to King's Chapel, in the same city. Had it been there refused, it was to go to Harvard College. This instrument was used at the chapel till 1756, when it was replaced by one imported from England, after approval, it is said, by Handel. The first Brattle organ is yet in use at the chapel of the Episcopal church in Portsmouth, New Hampshire, being now about one hundred and seventy years old, and, after some repairing, in good order. Of this second organ of King's Chapel the following notice appeared in a Boston paper of August 30, 1756: "We hear that the organ which lately arrived from London for King's Chapel will be opened on Thursday next in the afternoon, and that said organ, which contains a variety of curious stops, is esteemed by

eminent masters to be equal, if not superior, to any of the same size in Europe."

Eighty years later, another organ for the Brattle Street Church, made in England, by Greene, arrived in due time in Boston outer harbor. But violent opposition yet existed, and the opponents sought to prevent even its landing, offering, through their minister, to the master of the ship, to save him harmless and make good all losses if he would throw overboard all the cases in which the instrument was packed. The clergyman declined interfering; the dreaded instrument was duly put up, and, conquering all prejudice, held its place till 1872, when the church was removed, and a new organ by the Hooks & Hastings succeeded it. It was an excellent instrument in all respects, of two manuals, sixteen stops, and over a thousand pipes.

The first organ made in America was one by Edward Bromfield, of Boston, in 1745. In 1752 Thomas Johnston built another for Christ Church, in the same city. Another was built by him, in 1754, for St. Peter's Church, in Salem, Massachusetts. This manufacturer, dying in 1768, was succeeded by Dr. Josiah Leavitt, once a practicing physician of Boston, but whose strong taste for the mechanics of music induced him to relinquish his profession and devote himself to organ-building, which he continued for many years. The next manufacturer in date was Thomas Pratt, of Massachusetts, who was in the business in Boston from 1800 to his death in 1833. Contemporary with him (but in business as early as 1805) was William M. Goodrich, esteemed the "father of organ-building in New England," who established a reputation in the art so deservedly high by the fidelity of his work, the accuracy of his voicing, and the excellent quality of the tones of his instruments, that during his career but three foreign organs were imported into Boston. Associated with him afterward was his brother, Ebenezer Goodrich, and later, Thomas Appleton, many of the best organs of that day being the product of these manufacturers. The elder Goodrich died in 1833, Mr. Appleton continuing in the business and building many excellent instruments. He died in 1873 at Reading, near Boston, where in the latter part of his life he carried on his work.

About the year 1820 two young brothers, Elias and George G. Hook, of Salem, Massachusetts, the elder of whom had acquired a knowledge of the art under the Goodriches, commenced the manufacture of organs in that city. From the smallest beginning, and relying wholly upon thoughtful study and mechanical fidelity, they gradually enlarged their operations, and, removing to Boston for a larger field, have achieved a well-merited and widely-spread renown. The firm title is now that of E. & G. G. Hook & Hastings. Their organs,

exclusive of those built in the earlier portion of their business experience, number nearly 900 up to 1877, including many of the largest dimensions, and establishing their reputation as among the best artists of the world.

In New York, Adam Geib commenced the business as early as 1760, and seems to have been very successful, according to the standard of his day in this country. His son, John E. Geib, succeeded him, turning out many good instruments, one of which was erected in the North Church, in Salem, Massachusetts, remaining there from 1808 to 1847, when it was replaced by another instrument, built by Simmons & McIntyre, of Boston, and having more of the modern advantages. Geib also built various instruments for several churches in New York. About the year 1812 Thomas Hall started in the same city, continuing the business till 1875, the year of his death, at eighty-two years of age. He served his apprenticeship with a Mr. Loew, an English immigrant and organ-builder of much excellence, who established his business in Philadelphia early in the century. On the death of Mr. Loew, Mr. Hall succeeded him; but he seems to have transferred his establishment to New York, and to have had among his young noviciates in the trade Henry Erben, who, having served out his full time, became a partner in 1824, though but for a few years, since about the year 1827 he started a factory of his own, which in the half-century since expired has attained high rank and become renowned all over the land for its excellent instruments, about 700 having been turned out up to the present date. The firm, now Henry Erben & Co., made no exhibit at the Centennial Exhibition.

The house of Jardine & Sons, which also made no exhibit, but is here introduced historically, was originated by George Jardine, who, after serving his apprenticeship with the great London firm of Flight & Robson, settled in New York in 1837, where his brother had previously established himself as a piano-forte-maker. He had a thorough knowledge of music and its mechanics, acquired after many years' practice and experience, and, introducing many improvements and a variety of new stops, gradually built up a well-merited reputation. The instruments of the firm are to be found all over the United States, and have excellent reputation for mechanical ability, solidity of construction, and desirable quality of tonal effects. They have built, of all sizes, about 700 organs.

Other prominent organ-builders in New York are now Erben & Willson, Labaugh & Kemp, J. H. Odell & Co., and H. L. Roosevelt. The last only had an instrument at the Exhibition. Its deservedly high rank is mentioned elsewhere.

Something curious in the method of supplying air to the bellows of an organ is the method used at the organ of St. George's Church, New York. An iron tank, holding ten thousand gallons, is placed one hundred and fifty feet up in the steeple, and one of equal capacity at its base. During the week, water is gradually pumped up by a small steam-engine. The power generated by the water-pressure works the bellows, then falls into the lower tank, is pumped up again, and so goes on in perpetual round.

In Philadelphia, according to Bishop's *History of American Manufactures*, "an organ was ordered for Christ Church, from Philip Feyring, who had previously built one for St. Peter's." But where Mr. Feyring worked the author does not say. This instrument was in use from 1766 to 1833. It had three banks of keys, pedals, twenty-seven stops, and sixteen hundred and seven pipes. A few years later, Mr. D. Taneberger, a Moravian at Litiz, in Lancaster County, built an organ for the German Lutheran church in Philadelphia. In 1795 John Rowe commenced the business in the same city, and continued it to 1812, the year of his death. About the year 1795, Loew, an apprentice of the skillful Robert Gray, of London, established himself in Philadelphia, and such was his repute that he received the contract to build an organ for St. John's Chapel, in New York, in preference to any New York house. This was the organ captured on its passage to New York in the war of 1812, by an English frigate, and afterwards redeemed for $2000. Mr. Loew having died in the mean time, the organ was put up by Thomas Hall, one of his apprentices, who afterwards settled in New York and became renowned in the trade.

The organ exhibited by E. and G. G. Hook & Hastings stood in the gallery at the eastern end of the Main Building, its resonant tones being, when uninterrupted by the noise of visitors, clearly audible the entire length of nearly 1900 feet. Nor was it less noteworthy for the pure, rich quality and characteristic individuality of its several well-balanced registers. The instrument comprised four manuals, each of 58 notes, 47 speaking stops, 12 mechanical registers, including couplers, 10 pedal movements for combinations, etc., including a crescendo pedal controlling the full power of the organ. Total number of pipes, 2704.

GREAT ORGAN—14 STOPS.

1. 16 ft. open diapason	Metal, 58	8. 3 ft. twelfth	Metal, 58
2. 8 ft. open diapason	" 58	9. 2 ft. fifteenth	" 58
3. 8 ft. doppel-flöte	Wood, 58	10. 3 rank cornet	" 174
4. 8 ft. gamba	Metal, 58	11. 4 rank mixture	" 232
5. 6 ft. quinte	" 58	12. 16 ft. trumpet	" 58
6. 4 ft. flute harmonique	" 58	13. 8 ft. trumpet	" 58
7. 4 ft. octave	" 58	14. 4 ft. clarion	" 58

SWELL ORGAN—11 STOPS.

15. 16 ft. bourdon	Wood, 58	21. 4 ft. violina	Metal, 58
16. 8 ft. open diapason	Metal, 58	22. 3 rank cornet	" 174
17. 8 ft. viola	" 58	23. 8 ft. cornopean	" 58
18. 8 ft. stopped diapason	Wood, 58	24. 8 ft. oboe	" 58
19. 8 ft. quintadena	Metal, 58	25. 8 ft. vox humana	" 58
20. 4 ft. flauto traverso	Wood, 58		

CHOIR ORGAN—9 STOPS.

26. 8 ft. geigen principal	Metal, 58	31. 4 ft. fugara	Metal, 58
27. 8 ft. dulciana	" 58	32. 2 ft. piccolo	" 58
28. 8 ft. melodia	Wood, 58	33. 8 ft. clarionet	" 58
29. 8 ft. rohr-flöte	Wood and Metal, 58	34. 8 ft. vox angelica	" 58
30. 4 ft. flute d'amour	" 58		

SOLO ORGAN—2 STOPS.

35. 8 ft. stentorphon	Metal, 58	36. 8 ft. tuba mirabilis	Metal, 58

PEDAL.

37. 32 ft. bourdon	Wood, 42	40. 16 ft. trombone	Wood, 42
38. 16 ft. open diapason	" 42	41. 8 ft. bell gamba	Metal, 42
39. 16 ft. violone	" 42		

BY COUPLING.

42. 16 ft. bourdon.
43. 12 ft. quinte.
44. 8 ft. violoncello.
45. 8 ft. octave.
46. 8 ft. trumpet.
47. 4 ft. super-octave.

MECHANICAL REGISTERS.

48. Swell to great, coupler.
49. Choir to great, coupler.
50. Solo to great, coupler.
51. Great organ separation.
52. Choir, sub-octave.
53. Great to pedal, coupler.
54. Swell to pedal, coupler.
55. Choir to pedal, coupler.
56. Solo to pedal, coupler.
57. Swell to choir, coupler.
58. Tremolo swell.
59. Solo to itself, super-octaves.

PEDAL MOVEMENTS.

1. Forte combination pedal for great organ with appropriate pedal stops.
2. Mezzo combination " " " " " " "
3. Piano combination " " " " " " "
4. Forte combination " " swell organ " " " "
5. Piano combination " " " " " " "
6. Forte combination " " choir organ " " " "
7. Piano combination " " " " " " "
8. Full organ, all stops.
9. Reversible pedal for great and pedal coupler.
10. Crescendo pedal.

All manual couplers connecting with the great key-board were controlled by knobs directly over it, and operated by pneumatic motors applied to each note of the great manual and its couplers, to the pedal in part, and to the registers. All the combination pedals were double-acting, and operated without affecting combinations previously made by the registers. There were three bellows, the two main ones having vertical feeders, supplying 3600 cubic feet of compressed air per minute. An extra wind-pressure was used for the pedal, all motors, and a portion of the great manual, and independent bellows supplying wind, of great pressure, for the stentorphon and tuba mirabilis. Hydraulic motors operated the different bellows, placed below the organ on the main floor. The exterior comprised groups of metal and wood pipes, sustained by ornamental bands, above a substantial casing of walnut-wood, the larger metal pipes being grouped at the sides; between them, raised on a light, open arcade, were smaller pipes, behind and above which appeared the tops of the pipes of the solo organ; while above and back of all were seen the tops of the 32 feet bourdon pipes. The organ was 40 feet high, 32 feet wide, and 21 feet deep, and, because of ample space, nothing was crowded. The bellows and sound-boards were properly extended, admitting large scaled pipes, with sufficient speaking room, and easy access to every part for adjustment and inspection. An independent key-board or fourth manual was provided for the powerful tuba and stentorphon stops, as they could thus be made more available for solo use. The marvelous effect of these two stops, singly or combined, was unequaled. Noticeable also were the great power and variety of the pedal stops, the grandeur of the 32 feet contra-bourdon, and the advantages of the octave and quinte couplers applied to each pedal stop separately, so that the octave of any one or more stops might be used without affecting the others. In effect the five pedal stops were increased to eleven, and these were affected in proper order and selection by the grand crescendo and combination pedals, so that the manual stops would always have their complement of pedal stops.

The double-acting combination pedals, in connection with the pneumatic stop-action, pneumatic coupling-knobs, and the grand crescendo pedal, gave a system of great comprehensiveness and easy control, enabling the organist to have complete power over every part of the organ, and to effect all changes without removing his hands from the keys. The parallel feeders of the bellows, operated by water motors, gave a steady and full supply of air with but ten or twelve full strokes per minute, for full organ playing. There was an unusually high air-pressure, yet delicacy was obtained for the softer

stops, and for the diapasons, a most agreeable, smooth yet lusty tone.

We recall no organ of equal size and power that could be played with so much ease and satisfaction to the organist, or with so much gratification to the listener. The key, stop, and combination action were reduced to the minimum of resistance, and the utmost convenience was considered in the disposition of key-boards, registers, pedals, etc.

Another organ of the first rank was that of Hilborne L. Roosevelt, of New York City, the award to which by the Centennial Commission says, "It is an instrument of very large dimensions, having three manuals; is of good materials, and of skillful workmanship, exhibiting thoughtful ingenuity in its mechanism and construction, and in its grouping of facilities for the player. Its touch is light under every burden, its tones rich and delicate, yet firmly pronounced, the voicing —that of the English system—being equable, and not sacrificing the characteristics of the several registers to the power of the whole. The yield of sound in full blending is grandly effective. It has a convenient system of changeable-combination pedals, novel wind-chest, and draw-stop action; another novelty being its means of producing echo-effects by the application of electricity."

The scheme is as follows: Three manuals, compass C C to A^3—58 notes. Pedal compass C C C to F—30 notes.

GREAT ORGAN.

Double melodia	16 feet.	Fifteenth	2 feet.
Open diapason	8 "	Mixture	5 ranks.
Gamba	8 "	Euphone (free reed)	8 feet.
Dulciana	8 "	Ophicleide	16 "
Doppel-flöte	8 "	Trumpet	8 "
Harmonic flute	4 "	Clarion	4 "
Principal	4 "		

SWELL ORGAN.

Bourdon	16 feet.	Flageolet	2 feet.
Open diapason	8 "	Cornet	5 ranks.
Salicional	8 "	Cornopean	8 feet.
St. diapason	8 "	Vox humana	8 "
Wald-flöte	4 "	Oboe	8 "
Principal	4 "	Tremulant.	

SOLO ORGAN.

Violin open	8 feet.	Tuba	16 feet.
Concert flute	8 "	Tuba mirabilis	8 "
Doppel-flöte	4 "	Tuba clarion	4 "

ELECTRIC ECHO ORGAN.

Vox humana	8 feet.	Tremulant.
St. diapason	8 "	

ELECTRIC SUSPENDED ORGAN.

Traverse flute	8 feet.

PEDAL ORGAN.

Contrebass (resultant)	32 feet.	Bourdon	16 feet.
Open diapason	16 "	Violoncello	8 "
Contrebass	16 "	Trombone	16 "

COUPLERS.

Swell to great.	Swell to pedal.
Solo to great.	Great to pedal.
Solo to great octaves	Bellows signal.
Solo to great sub-octaves.	Water-engines.
Solo to pedal.	

COMBINATION PEDALS.

Great organ forte, or full organ.	Solo organ forte.
Great organ mezzo.	Piano pedal.
Great organ piano.	Reversible coupler.
Swell organ forte.	Great to pedal.
Swell organ piano.	

COMBINATION KNOBS.

Full organ.	Piano organ.
Mezzo organ.	222 small knobs for setting combinations.

The mixture, fifteenth euphone, trumpet 16 feet, trumpet 8 feet, clarion 4 feet, of the great organ, are placed in the swell-box, making a remarkable crescendo effect when used with the swell organ. The instrument was 42 feet wide, 20 feet deep, and 40 feet high, containing great organ, swell, solo organ, pedal organ, electric echo organ, and electric suspended organ. It occupied a central position in the north gallery of the Main Building, and, being exhibited as a specimen of a new American school of organ-building, was intended to illustrate the progress made in the art in this country. Though founded on the best modern European schools, the improvements introduced were for the most part new and American in their origin. The wind-chests were novel in their construction, each pipe having a separate valve, these valves being connected together and to the keys by a combined pneumatic and tubular action, not affected by the changes in temperature, or liable to cipher. The combination pedals

and knobs were peculiarly novel, being so arranged that the organist can, from the keys, readily change or set a combination on any pedal, from one stop to the full organ. The electric suspended organ was hung directly in front of the gallery, connected to the great organ by a cable of insulated wires, and operated by six cups of the famous Leclanché battery, the electric echo organ being situated in the English tower, and connected to the great organ by a small cable, 250 feet long, the action being operated by a Leclanché battery. The voicing, on which mainly depends the success of the instrument, was deserving of close study and examination by those interested in the subject. The great delicacy and characteristic quality of tone of the different stops, and the immense power, without harshness, of the full organ, were the result of a most careful school of voicing, combining all the best points in European voicing with some effects never before produced.

Another church-organ of very high rank, with two banks of keys, was exhibited by E. F. Walcker & Co., of Ludwigsburg, Germany, the justly celebrated builders of the great organ in the Boston Music Hall. It stood upon the floor, on the principal passage of the Main Building. Its case was of oak and in Gothic style. Its wind-chests were constructed after the maker's newly-invented system of conical valves without springs, the chests by their great solidity resisting every variety of climate. The wind was supplied by three piston-bellows, distributing air with the utmost equality. All the mechanism and the workmanship were faithfully and reliably executed. It was 15 feet from front to rear, not including the key-board, which was separated from the instrument and in its front, covering a space, with the seat, of about 5 by 4 feet, the player facing the audience; about 13 feet wide and 12 feet high at the rear, and 18 feet to the top of the central front, Gothic finish. It contained 19 speaking registers; 16 with 56 pipes each, 3 with 30 pipes each, 3 couplers, and 8 composition pedals. The total number of pipes was 1098, its entire compass being from C C to G,—56 notes,—in both great organ and swell organ with C C C tō F, two and a half octaves of pedals. It was an instrument of the highest excellence, combining power with brilliancy and delicacy of utterance. Its several registers were pronouncedly individual in their characteristics, and the blending of the whole was impressive, solemn, and grand. The materials used were of superior quality and the general workmanship excellent. Its specifications were as follows:

GREAT ORGAN (C C to G—56 notes)—728 PIPES.

1.	Bourdon, 16 ft., wood	56 pipes.
2.	Principal (open diapason), 8 ft., pure English tin in the front	56 "
3.	Gedeckt (stopped diapason), 8 ft., wood	56 "
4.	Viola di gamba, 8 ft., proof tin	56 "
5.	Hohl-flöte, 8 ft., wood	56 "
6.	Octave, 4 ft., proof-tin	56 "
7.	Rohr-flöte, 4 ft., metal	56 "
8.	Mixture, 2⅔ ft., 4 ranks, proof-tin	224 "
9.	Clarionet, 8 ft., free reeds	56 "
10.	Physharmonika, 8 ft., free reeds	56 "

SWELL ORGAN (C C to G—56 notes)—728 PIPES.

11.	Principal, 8 ft., the lowest octave wood, continuation in proof-tin	56 pipes.
12.	Lieblich gedeckt, 8 ft., wood	56 "
13.	Salicional, 8 ft., the lowest octave wood, continuation in proof-tin	56 "
14.	Travers-flöte, 4 ft., overblown, wood	56 "
15.	Trumpet, 8 ft., reeds	56 "
16.	Physharmonika, 8 ft., free reeds	— "

PEDAL ORGAN (C C C to F—30 notes)—1098 PIPES.

17.	Sub-bass, 16 ft., wood, stopped	30 pipes.
18.	Violon-bass, 16 ft., wood, open	30 "
19.	Violoncello, 8 ft., wood, open	30 "

COUPLERS.

20. Swell to great organ (II. man. to I. man.).
21. Swell to pedal organ (II. man. to ped.).
22. Great organ to pedal organ (I. man. to ped.).

COMPOSITION PEDALS.

23. Tutti (to act full organ).
24. Forte (to act stops Nos. 1 to 8, 11 to 14, and 17 to 19).
25. Piano (to act stops Nos. 3, 4, 5, 17, and 19).
26. Tutti, II. man. (to act full swell organ).
27. Swell-pedal to II. man. (swell organ).
28. Swell-pedal to physharmonika.
29. Piano-pedal to physharmonika.
30. Tremulant to physharmonika by pedal.

PARLOR-ORGANS.

Of these instruments, sometimes called harmoniums, or vestry-organs, there was an excellent exhibit. They belong to a class of comparatively recent invention, which, growing rapidly into favor, because supplying a want not met by any other instrument of this variety, have assumed a positive commercial importance, and summoned great inventive talent and skill in their manufacture and pro-

gressive improvement. Their tones are produced by the passing of air through free reeds, brass tongues being fixed at one end and left free to vibrate at the other on impulse of air, and so yielding musical tones. Their peculiar characteristics are volume, compass, delicacy, and sustained expression, with ease of producing increase or diminution of utterance. The wind is supplied by arrangements controlled by the player, or, as in the larger ones for vestries or small churches, by an assistant at the rear or side. The importance to which the manufacture of reed-organs has attained in the United States is attested by the fact that there are about fifty thousand such instruments made yearly in this country by about two hundred and fifty manufacturers. Under the general name of reed-organ are included all instruments played upon by keys like those of the piano-forte, and yielding their tones by the vibration of their reeds.

The first evidence of the manufacture or use of such instruments in America occurs in a patent, granted in 1818, to Aaron Merrill Peasley, for "a new and useful improvement in organs." Messrs. Mason & Hamlin have this patent in their possession. It is so broad in its terms as to show that no instrument of the class could, at the time, have been known to the Patent Office authorities, and so far to warrant the claim that this was an American invention. But instruments are still in existence respecting which it is declared that they were made in Germany previous to the date mentioned. The first instruments of the class were, however, very poor, and no considerable demand for them arose until certain improvements were introduced by two manufacturers in Buffalo, New York, Messrs. Carhart & Needham and Prince & Co., about the year 1850. The former were the first to successfully employ and introduce the exhaust-bellows, now universally employed in these instruments in America. Thus improved, the instrument, under the name of the melodeon, obtained considerable use. About this time Mr. Emmons Hamlin, now of the Mason & Hamlin Organ Co., discovered and developed the art of voicing reeds, which has proved the most important of the improvements in such instruments, modifying and bettering the qualities of tone obtained from them. It is now employed by all American makers, and is beginning to be used in Europe. The demand for the melodeon increased in proportion to its merits. In 1860, Mason & Hamlin made further improvements in the instrument, using two blow-pedals in place of the one commonly used before, producing a better current of air, and effecting a more even delivery of tone. They also returned to the name "organ." This form and name were followed by other makers, and soon became universal in America.

Meanwhile the force-bellows continued in use in this class of instruments in Europe. It is only recently that the advantages of the exhaust-bellows have been appreciated and employed there. Undoubtedly America now manufactures a greater number of reed-organs than any other country, and the fact that one of our manufacturing concerns has been awarded a first medal at each of the European Expositions at which it has exhibited, and that we export such instruments largely and import very few, would seem to indicate high attainment in this branch of manufacture.

Napoleon Fourneaux made harmoniums (*orgue expressif*) in 1836. They were in box-shaped cases, and the bellows were operated by the foot. They had no stops, each set of reeds having a separate keyboard.

Alexandre-François Debain introduced harmoniums with stops and other superior features in 1841. These instruments were so superior to the others named that Debain has always had the credit of being the first to make harmoniums. This is accorded him in the publications referring to the French Exposition of 1867.

The earliest imported harmonium now remembered was seen in the work-room of the late Jonas Chickering, about the year 1836, at his piano-forte-factory in Boston. It was imported by him from M. Alexandre & Sons, Paris, who had then attained considerable celebrity. Their house, founded in 1829, for many years supplied the European demand. But the rapid gain of the instruments in public favor allured capital and skill, and now England and Germany are largely engaged in their production and are sending out hundreds of excellent instruments.

The low cost of the generally-used harmonium, its compactness of form, the ease of its management, the generally pleasing nature of its tones (the French call it the *orgue expressif*, or "organ of expression"), and its adaptation to its class of music, the less rapid and difficult, which renders the learning to play upon it a not very difficult task,—all combine to win for it a great deal of favor, and it is rapidly becoming an inmate in musical families whose means may not be equal to obtaining the more costly piano-forte.

Besides the instruments exhibited by Mason & Hamlin,—all of the very first class,—excellent specimens were presented by Peloubet, Pelton, & Co., of New York; Taylor & Farley, of Worcester, Massachusetts; the Burdett Organ Co., of Erie, Pennsylvania; the Dominion Organ Co., of Bowmanville, Canada; the Clough & Warren Organ Co., of Detroit, and the Dominion Company of Canada; J. Scheidmeyer, of Stuttgart, Würtemberg (not for award), and G. L.

Bauer, of London. All these were of excellent, even, and expressive quality of tone, well-voiced, resonant yet pure, and with much variety in combination.

So far as is known, Mr. Peloubet, of the firm above named, was the first to apply the equal temperament in tuning the reeds, and in enlarging to three banks of keys. In addition to the above names, but not in competition, we find, engaged in the trade, S. D. & H. W. Smith, of Boston; Estey & Co., of Brattleborough, Vermont; G. A. Prince, of Buffalo, New York, and Carhart & Needham, of New York; the latter introducing several new and valuable improvements. They were the first to carry the bass down to thirty-two feet C, and to introduce the exhaust-bellows now in general and approved use. The Prescott Brothers, of Concord, New Hampshire, now the oldest firm in the country; M. O. Nichols, of Syracuse, New York; Peter J. Jewett, of Granby, Connecticut (1833); Jewett, of Worcester, Massachusetts (1837); Swan, of Cherry Valley, New Hampshire (1839); Packard, of Bridgewater, Massachusetts, and Phelps & Goodman, of Syracuse, New York (1850), were pioneers and followers in the trade, and should be commended for persevering efforts at improvement.

VIOLINS.

Of the class of musical instruments to which these belong there was a very full and satisfactory exhibit, many of them being of American manufacture, and some the product of machinery especially invented.

The low price at which very good instruments of this class may be bought was noticeable, as was the fact that cheapness in this case did not always imply inferiority. The violin has remained with very slight, if any, changes for nearly two and a half centuries, the kind of wood used and the models remaining substantially the same as those of the days of illustrious makers, Stradivarius, Amati, Guarnerius, and Albani. There were two violins made by Emmons Hamlin, of the firm of Mason & Hamlin, of Boston, of marked excellence and with much of the characteristic quality of those of the old makers of two centuries ago. Admirable exhibits were also made by the Alberts, and Neff, of Philadelphia; by Subenhühner, of New York; and Glasel, of Germany. Gemunder, of New York, presented a contra-basso of first-rate make, and of rarely excellent qualities in every respect. John F. Stratton, of Leipsic and New York, manufacturing for the trade, exhibited an extensive collection of stringed, wood, and brass instruments of good workmanship and cheap in price, many of which, at the same time, were of good quality and excellent tone.

The manufacture of these instruments in the United States can hardly be said to have a history. Few persons have adopted the trade as a specialty, and fewer, if any, have met with encouraging success. Among the few names which we have heard associated therewith are Benjamin Crehore, who, in 1785, manufactured violoncellos at Milton, Massachusetts, and who afterwards became a maker of piano-fortes, and Samuel Long, of Hanover, New Hampshire, who, about 1812–20, without previous instruction in the art and with no aid from machinery, made excellent instruments, using old and well-seasoned stock. Abraham Prescott, of Concord, New Hampshire, 1825–35, was engaged in the same line, in making violoncellos and contra-bassos. He afterwards, with a brother, went into the manufacture of melodeons. As a rule, among these early makers, some errors in their proportions weakened sonority and general effect. To remedy this difficulty, and to eradicate the prejudice against instruments of fresh make, is not easy, yet both will be accomplished as experience ripens skill. The introduction of instruments made from carefully-selected old wood, and constructed with due regard to the proper adjustment of the parts, will go far in that direction. Such instruments will require but very little time to bring them into extensive use. The application of machinery in the manufacture of stringed instruments will probably be limited to the mere roughing out of the breast and back. After that must come artistic skill and delicate exactness of finish, and these are now directed by the most thoughtful and ingenious manufacturers towards the permanent improvement of the quality of the instrument. Among names also worthy of mention are Warren A. White, of Boston, who obtained considerable reputation and a large demand because of his skill and the general good character of his instruments. Mr. John White, also of Boston, was a successful manufacturer, the top of one of his instruments being, it is said, made from wood of an old organ presented to the town of Cambridge in 1767, and the back and hoops from the communion-table of the old church at Lexington, Massachusetts.

Other names of note are George Gemunder, of New York, and Calvin Baker, of Weymouth, Massachusetts. Both have produced fine instruments. Yet the enormous influx of foreign products in this line, many made to sell, of poor, unseasoned stock, with small regard to truth of adjustments, puts our own makers at serious disadvantage, not only because of competition, but because players, as is above hinted, have always strong prejudices in favor of old, time-seasoned instruments.

BAND INSTRUMENTS.

Of the history of the manufacture of orchestral and band instruments in the United States little that is satisfactory or reliable is known. The first maker of band instruments in New England was probably Samuel Graves, at Winchester, New Hampshire, who subsequently established himself in Boston, and now resides at the former place. Henry Sibley, early in the century, and afterwards E. G. Wright, a man of much skill, worked in Boston, and later, Allen, Fisk, Hall, and Hall & Quimby, all excellent in their art. Many years since, there appears to have been in New York a Mr. Torenzi, probably an Italian, who made, first in this country, ophicleides and kindred instruments. The trade itself may be dated as having its inception in the United States about the year 1825. It is now very widely diffused, and its products rival those of European makers. Among the prominent and successful manufacturers is a firm established in Boston in 1840 by J. L. Allen, succeeded in 1861 by Hall & Quimby, which, continuing to 1875, became the firm of Quimby & Brothers. This now well-known house, by its thorough workmanship and the excellence of its instruments in material, finish, and tone, has attained just celebrity, supplying every variety demanded by bands of the best character. Other manufacturers in good repute are George McFadden, of Syracuse, New York; Conn & Dupont, of Elkhart, Indiana; and Isaac Fiske, of Worcester, Massachusetts.

In this department there was a profuse as well as most admirable display by both foreign and native makers, all classes of the exhibits manifesting valuable novelties for production of better effects, exquisite accuracy, beauty of finish, and thoroughly good workmanship in every particular. Careful and scientific grading of the wind-passages had been secured, producing excellent quality, purity, and truthfulness of tone; an exact and happy arrangement of keys insured facility in fingering; while the quiet working of these keys, and the power and far-reaching capabilities of the several instruments, all testified to the successful appliance of scientific thought, inventive skill, and accurate handiwork. Those who remember the instruments of half a century ago, with their many and acknowledged defects, are at once surprised and gratified at the results achieved by later efforts and inventions in this field of musical art, demonstrating, as they do, the application of correct acoustic principles and accurate construction. For the brass instruments of the older bands, the trumpets, trombones, and horns, and for the serpents, bassoons, and other instruments, more or less deficient in ease of manipulation and in general tonal effect, we

have admirable substitutes in great variety, with keys, pistons, and general improvements of a greatly varied character, upon which more difficult and more satisfactory music, more effective as well as more scientific in its composition, is played with comparatively easy execution, even with less persistent practice than was demanded by the less varied and now less used instruments of the older date. Nor is there any loss of purity in the harmonics or in the resonance of the newer ones, for they possess a justness in intonation and a degree of freedom such as even experts found it difficult to attain on the mere harmonic instruments of the old school.

It is not certain who originated the system of valves, but about the year 1825 valve instruments were used by order of the Emperor of Russia in a band of one of the regiments of Life Guards. It is claimed that a Mr. Adams, of Lowell, Massachusetts, invented them, applying three of them to a horn, which he took with him on board a United States ship-of-war on a cruise up the Mediterranean. When in a French port the novelty attracted notice, was at once adopted by manufacturers abroad, and the credit of the invention departed from us.

We have then horns, trumpets, trombones, and cornets constructed on scientific principles, and possessing greater power, more impressive resonance, and greatly attractive richness of tone. Of these qualities, the sax-horns, invented by Adolphe Sax, of Paris, are notable examples.

In fact, there has taken place within the century an almost total revolution in the instruments of military bands, of which the saxophones—instruments with reeds like those of a clarionet—may be taken as an example of striking originality in tone, and greatly contributing to musical expression in both band and orchestra.

Among the exhibitors of the best of these instruments in brass may be classed Besson, of London; Mahillon, of Brussels (author of an admirable treatise on wind instruments); Farsky and the Fuchs, of Austria; Alberg & Ohison, of Sweden; the "Boston Musical Instrument Manufactory," of Boston; and H. G. Lehnert, of Philadelphia. A similar improvement was noticeable in several pulsatile instruments; the drums, though reduced in size, were increased in resonance and far-reaching sonority, and the cymbals, etc., were of reduced dimensions, more easy manipulation, and lighter, yet with no loss at all in power and effect. Similar praise may be bestowed upon the guitars and the zitherns, as well as for their much better finish; even the banjo having received careful attention, and consequent improvement in workmanship and in tone.

Of the smaller musical instruments, the guitars, zitherns, accordions, concertinas, mouth-harmonicas, tambourines, and banjos, there was quite a large exhibit by various manufacturers, and of much excellence in their kind. The zithern (cithara) is hardly known here or in England, but is much used on the Continent. It is a species of guitar with added strings for re-enforcing the harmony. Like the guitar in Spain, it is used to accompany the voice in singing.

AUTOMATIC MUSICAL INSTRUMENTS.

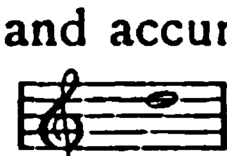
Quite a number of self-acting instruments, known as orchestrions, were on exhibition, some of large size; with ingenious and elaborate mechanism. These are intended to supply, in the compass of a single instrument, the effect of a full orchestra, or a full band, and are chiefly used in exhibitions like those of a museum or of a traveling circus-show. Though not yielding the most delicate or refined music, theirs being generally of a very full and pronounced character, they are well adapted to the field for which they are intended. Yet several of them were specimens of very skillful workmanship and most ingenious mechanism. Such were the orchestrions of Welte & Sons, of Germany, and Gavioli & Co., of Paris. Such also were the several music-boxes in the Swiss department, some of them being of extraordinary size, capabilities, and effects, and yielding music of a most pleasing character. Those exhibited by Messrs. Paillard & Co., St. Croix, Switzerland, were among the very best of their kind, having much novel and ingenious mechanism, giving clear, resonant, and pleasing tones, quite orchestral in their effects. Other excellent and praiseworthy instruments of this class, very attractive for their ingenuity and musical effect, were presented by Bremond, Karrer, and Adank, all of Switzerland, where the manufacture of this class has long been a successful specialty. In both workmanship and tonal results they were all admirable.

MUSICAL ACCESSORIES.

The many excellent exhibits of various accessories to musical instruments were entitled to great commendation. These were felt cloths for piano-fortes by Dolge; piano leathers by Schlesinger & Lammer and the Geyers, of Germany; reeds for parlor-organs by the Ingalls Reed Company, and the Monroe Reed Company, of Massachusetts; the double sounding-boards by Koch, of St. Petersburg; the violin strings by Mueller, of Saxony, and Stratton, of Leipsic and New York; the strings of Grandjon, of Paris, for all varieties of bowed instruments, also his bows, bridges, keys, cases, and other

accessories of various kinds; the piano-forte wire by Poehlman, of Nuremberg, of remarkable tensile strength, and of Washburn & Moen, of Worcester, Massachusetts, of beautiful and even finish; the organ-pipes of Zimmerman, of Paris, of admirable workmanship in every respect; and woods for sounding-boards, ivory keys, etc., by several exhibitors, native and foreign, all of great general excellence, and entitled to much credit.

BELLS.

In 1736 a foundry for casting large bells was established at New Haven, Connecticut, by Abell Paombe, who, in his petition to the General Court of the State, declares that his was the first attempt made in the colonies. Another earlier casting of bells was by Mr. Hanks, in Mansfield, Connecticut, at a place called Hanks' Hill. He also, at the time of the Revolution, cast bronze cannon for the American army. About the same time, Aaron Hobart, at Abington, Massachusetts, engaged in the same work of casting bells, cannon, and shot. At Stoughton, in the same State, a bell-foundry was established in 1770. The celebrated Paul Revere, of Revolutionary fame, cast bells in Boston prior to 1790. But it is to be noted that, in these earlier efforts, the casting of bells was connected with other miscellaneous casting, not appearing to have been made a specialty, as is now the case in many establishments, where experience and skill have reached such a point that one may be sure his order will be answered with entire exactness and accuracy of tone, whether it be for a small bell of 400 pounds on , or a large one of 6000 pounds on .

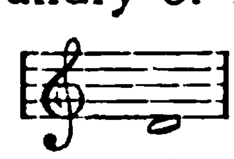
Among well-known houses in Boston was that of Henry N. Hooper, who died in 1865, after establishing an extensive business and gaining high repute. He was succeeded by William Blake, who was for some years associated with Mr. Hooper, the firm being now that of William Blake & Son. Mr. Blake, beginning the business in 1820, died in 1871, being one of the oldest in the trade. The bells of this firm bear a deservedly high rank.

Among other noted bell-founders are Holbrook, of Medway, Massachusetts, dating from 1825, the establishment being still continued by his successors; Meneely & Kimberly, of Troy, New York; Vanduzen & Tift, of Cincinnati; McShane, of Baltimore; and Meneely & Co., of Troy, New York. This latter firm dates from 1826, when it was established by Andrew Meneely, the name continuing in the firm to the present time. Their bells bear a very high reputation, being cast from rigid formulæ, and securing the desired

tones with uniformity and success. Indeed, no firm can succeed in this business except by persistently following precise mathematical rules, and using the most perfect mechanical appliances. In exact ratio to compliance with these laws and these means will be the success of any foundry. Of chimes and peals alone, the Meneely firm have cast, since 1840, nearly one hundred.

The earlier bells in America were all imported, those of Quebec being probably the earliest, and used in the Catholic churches and convents. From thence their use spread wherever the Catholic missionaries carried the gospel. Every little chapel they erected in the wilderness, and wherein they preached to the Indians, had its bell to summon the red men to mass. There is one of them in the museum of Bowdoin College, in Maine, which belonged to the chapel of Father Ralle, killed by the Indians in 1724, at Norridgewock, Maine.

The Independence Bell was cast in England in 1752, broken, and recast under direction of Isaac Morris, by Pass & Stow, and placed upon Independence Hall. Removed to Lancaster on occupation of Philadelphia by the British in 1777, it was returned in due time, being afterwards used on state occasions, the last ringing being in honor of the visit of Henry Clay, in 1828, when it broke. It was then placed in the Hall, where it yet remains.

At the Centennial Exhibition there were excellent exhibits of bells, one being a full chime from the foundry of Henry McShane & Co., of Baltimore, of thirteen bells from  upwards. These were mounted in a tower at the eastern end of Machinery Hall, and played every day. They were of clear and good tone, and with quite correct overtones, considering that they were set up immediately after casting with no especial tuning. Schmidt's rotary yoke, used with these bells, gives the great advantage of permitting a bell to be turned from time to time, as exigency may demand, so that the blow of the hammer may not always strike on the same part, and so, by continued impact, weaken the point and endanger cracking.

Two other bells, one cast by the brothers De Poli, of Italy, and the other by Hadank & Son, of Germany, attracted particular notice because of their excellence in casting, elaborate ornamentation, volume and purity of tone, and well-defined and correct harmonies. Another exhibit of bells in the Main Building, about a dozen in number, of various sizes, weights, and tones, was made by Messrs. Vanduzen & Tift, of Cincinnati, Ohio, all of which were of first-rate workmanship and material, accurate in tones and overtones, clear in resonance, and highly creditable to the manufacturers.

A large bell of some 3500 pounds in weight, by William Blake & Son, Boston, Massachusetts, intended as a fog-bell, with automatic apparatus for tolling, and to be placed on some dangerous headland, was on exhibition near the Government Building. It was a  bell, admirably cast, with great accuracy in overtones, and of clear and far-reaching resonance.

Hand-, house-, and sleigh-bells, of great variety and of excellent quality and resonance, were exhibited in the Main Building by the Bell and Gong Manufacturing Company, of East Hampton, Connecticut.

The fog-horn of Brooks, of Boston, operated by blasts of steam, made a lasting impression at the Exhibition. It was a most successful noise-maker, heard easily by residents a dozen miles distant, and was reputed to have a sound-carrying power of thirty miles, giving ample warning to vessels nearing dangerous points upon sea-coasts. For this purpose it is admirably adapted.

MUSICAL TYPOGRAPHY.

In this department of the music trade, those who remember the feeble and imperfect efforts, and the ordinary, cheap, and coarse work turned out during the last quarter of the eighteenth and first quarter of the nineteenth centuries, both in Europe and in the United States, will doubtless readily testify to the almost incredible improvement which has followed, and which seems to be rapidly attaining perfection. The art commenced in the fifteenth century with engraved fragments on wood for missals and for some few educational works. But musical typography, rigidly so called, by means of movable types of metal, was not invented till near the beginning of the sixteenth century, when Octavien Perucci, of Fossombone, in Italy, produced some specimens from his presses. He was early quite successful, and his example was followed by printers in Italy, France, and Germany. England took it up, and has now attained eminent success, in producing, at cheap cost and in most convenient form, a vast quantity of the works of the best composers, the publications by the house of Novello & Ewer, of London, leading, whose agency in this country is with J. L. Peters & Co., of New York, who, also, issue works in the highest excellence of the art. Oliver Ditson & Co., of Boston, are likewise among the leading publishers, and issue an immense amount of music in commendable style, providing for the wants of both the beginner and the expert. Among other extensive publishers are G. D. Russell, of Boston; Pond & Hall, in New York;

Church & Co., and the Brainards, in Cincinnati; André, and Louis Meyer, in Philadelphia, and very many others, representing a business in which more than three millions of dollars are invested. At the Exhibition, very many and attractive specimens were shown.

HOROLOGICAL INSTRUMENTS.

BY JAMES C. WATSON.

The exhibits were not equally complete in all the departments of horology, but still they were from all countries which have any considerable manufacture in the way of horological instruments, and the productions of some of the most famous manufacturers were represented. The number of clocks exhibited was not very great, but some of them were remarkable for novelty of construction or for exquisite workmanship. The number of marine chronometers was considerable, including the productions of the best American, English, Swiss, French, and Dutch makers. The display of pocket chronometers and watches was very large, and their examination occupied a very considerable portion of the time of the Judges. For the first time the products of our American manufacturers were exhibited at an International Exhibition. The best English, French, and German makers exhibited numerous specimens of their work, while the Swiss made a display in number and variety sufficient to indicate, to even an uninformed observer, the extent and the perfection of this industry in their country. Besides these, there were exhibited various other horological instruments, which will be mentioned in the course of this report.

Instead of describing the various productions of single exhibitors under one head, it will be better to bring together the productions in a single class, and hence often it will happen that the full knowledge of what was exhibited by a single manufacturer can only be obtained by consulting this report as a whole. In accordance with this scheme, various forms of clocks will first be considered, commencing with turret clocks, then marine chronometers, and, finally, pocket chronometers, watches, and miscellaneous horological instruments.

I. TURRET CLOCKS.

It is scarcely more than a quarter of a century since it was considered possible to construct a turret clock with any considerable pre-

tensions to accuracy as a time-keeper. The unstable character of the mounting, the changes of climate, the violence of storms acting upon the exposed pointers of the dial, and hence upon the train, and the mechanical difficulties arising from the great size and weight of the parts, were such as to make it appear futile to construct such a clock with the care which would be expended upon one for accurate time-keeping. The invention of various forms of isodynamic escapements, simple to execute and reasonably certain in their continued action, made it possible to use a train less highly finished, and hence to construct even tower clocks with a degree of perfection hitherto unattainable. The number of such clocks annually constructed is considerable; but notwithstanding the importance of the industry in this particular branch, there were only a few tower clocks on exhibition, and these we proceed to describe.

SETH THOMAS CLOCK COMPANY, *Thomaston, Conn.*

In Machinery Hall, in actual operation in the tower, was a large turret clock, solidly constructed and finished in excellent manner throughout. The wheels were of gun-metal, and carefully finished, so as to secure the theoretical requirements for smooth action of the train. There is nothing new in connection with this clock which requires description, and the award which was made was on account of excellence of workmanship in its manufacture and intelligent application of theory in its design. The escapement is that known as Denison's double three-legged gravity escapement, the execution of which has been effected with the very best workmanship possible. Hence, as might be expected, the action of the escapement was found to be excellent. The driving-weight weighs 200 pounds. The pendulum is zinc and steel compensation. The weight of the pendulum-rod is 200 pounds, and of the pendulum-ball 500 pounds. The great weight of the whole pendulum, 700 pounds, requires that provision be made against injury resulting from the accidental breaking of the pendulum-spring, and such protection was duly provided. The exhibitors stated that repeated trials have never shown any case of tripping in the action of the escapement, and that considerable changes of weight applied to the train did not sensibly change the arc of vibration of the pendulum. A careful inspection of the parts showed that great care had been taken not only in the finishing of the acting surfaces of the escapement, but also in the exact adjustment of their positions as required by theory, so that it is reasonably certain that, undisturbed, this clock will perform its functions with great precision, while, under the vicissitudes to which it may be subjected, its perform-

ance will be as perfect as can be secured by this approved form of construction.

CHARLES FASOLDT, *Albany, N. Y.*

This clock, exhibited in the Main Building of the Exhibition, was constructed upon a new plan, invented by Mr. Fasoldt, and successfully carried out in a number of tower clocks constructed by him, and showed great excellence of performance in actual use. The essential idea of Mr. Fasoldt's construction is to employ an accurate clock, of moderate dimensions, to control the motion of a turret clock in connection. It would, of course, be immaterial, so far as relates to the clock controlled, what the form of construction of the controlling clock might be; but Mr. Fasoldt's merit is to be considered in this case in reference to both parts. We shall, therefore, consider first the construction of the controlling clock, which may be used as well for a standard time-keeper, independently of its adaptability for the purpose of controlling a turret clock in connection.

The principal novelty in the construction of this clock is in the escapement, the arrangement of which is the invention of Mr. Fasoldt. It is of the class known as gravity escapements, the impulses to the pendulum being given by a gravity-arm or lever, whose oscillations are created by the escapement. There are in reality two scape-wheels, one for locking and unlocking, the other for communicating the proper motion to the gravity-arm for the impulse of the pendulum. There is upon the arbor of the impulse escapement-wheel a toothed wheel, which gears into a pinion on an arbor, which carries a sectional or locking-wheel. This wheel has a suitable number of projecting arms, which may be two, four, six, or more, as may be required. The arms of this sectional wheel are arrested by the pallets, which are jeweled, and so inclined as to give the minimum of friction in unlocking. One of the locking-pallets is slowly unlocked, being near the axis; the other quickly, being farther from the axis. To the supporting frame of the clock is pivoted a lever, the upper end of which is connected with the pendulum by means of the crutch, while the other extremity carries an unlocking piece, which is moved by the motion of the pendulum alternately over the inclined inner faces of the fork attached to the escapement-lever. Suppose now that the sectional scape-wheel, symmetrical with respect to its axis, has at each extremity two projecting arms. Every vibration of the lever connected with the crutch will produce, by its contact with the fork, a vibration of the escapement-lever, and every other vibration of this lever w ll bring another arm of the section-wheel in contact with it.

Thus, if the sectional locking-wheel has but one arm with two detents at the end, it will make one rotation at every back and forward motion, and impart one impulse to the pendulum through the gravity-arm. By four detents on one or each arm, one impulse is imparted to the gravity-arm, the same having made four oscillations; by six detents, six oscillations and one impulse, etc. The motion of this wheel is so related to that of the impulse escapement-wheel, that the latter is moved the space of one tooth during each rotation of the former, or part of rotation, as the case may be.

To a projecting arm of the crutch-lever is pivoted a gravity-lever, whose lower end is suspended directly over the impulse-wheel, and at whose upper end is an arm carrying an adjustable weight. Whenever the impulse-wheel is turned, one of its teeth bears against the lower end of this gravity-lever, and moves it along, thereby giving the requisite impulse to the pendulum. After the tooth of the impulse-wheel has carried the gravity-lever to the end of the impulse, this lever remains in that position until drawn out by the oscillation of the pendulum; then it drops upon a resting-pin, projecting from the crutch-lever, into a neutral position, and it is, in such position, carried clear of the teeth of the impulse-wheel during the return vibration. As soon as the crutch-lever commences to swing in the opposite direction, the gravity-lever will be at once acted upon by the next tooth of the impulse-wheel, and so on. The motion of the scape-wheel is so regulated that the locking and unlocking of the pallets is always secure, and error from tripping entirely avoided. The records of the performance of clocks with this escapement show excellent results.

By a suitable device for the suspension of the pendulum, the gravity-lever may be attached directly so as to obviate the necessity for the use of a crutch, thus simplifying the movement somewhat. The clock exhibited has a pendulum with mercurial compensation, and an adjustment of the faces which hold the pendulum springs so as to compensate for unadjusted circular and escapement errors.

When applied to turret clocks, no modification of the movement just described is necessary. Its functions are performed in entire independence of the connection with the turret machinery, although so connected that the motion of the latter is under its control. Its regular motion is not, therefore, interrupted by any irregularities in the movements of the hands upon the great dials, produced either by the influences of the weather or other causes, and the correct time may be indicated on any required number of dials without correspondingly enlarging the size and power of the clock mechanism.

Power is imparted to the clock-train and to the hand-driving mechanism by separate weights.

To the main arbor of the clock-train is attached an unlocking-wheel, which has a greater or smaller number of teeth, according as the forward motion of the minute hands upon the great dials is intended to be performed in greater or smaller intervals of time; for example, at every half or whole minute, or otherwise. The teeth of this unlocking-wheel engage a V-shaped fork, that is firmly applied to a separate arbor of the clock-train, and raised by one tooth after the other as the wheel rotates, to be dropped when carried up till the contact of the tooth and the upper arm of the fork is discontinued. To the outer end of this arbor is attached an arm, with projecting rest or guard-plates at one or both ends, that follow accurately the motion of the arbor, by being alternately raised and dropped therewith. The control of the hand-driving mechanism is now effected in this manner. The guards or rests just mentioned serve to arrest and release the end of a balanced spring-arm, which is keyed to the shaft of a small revolving pinion, which meshes with a toothed wheel of large but accurately-proportioned size, applied in a fixed position to the clock frame. The shaft of the revolving pinion is supported in bearings of a frame keyed to the end of the arbor, passing through the centre of the large fixed wheel, and accurately balanced by being weighted at the diametrically-extended arm of the same, so that the swinging of the frame and the complete revolution of the pinion around the circumference of the fixed wheel are accomplished with the desired perfection of motion. This motion of the pinion and balance-frame around the fixed wheel forms the intermediate locking and liberating mechanism of the clock-train and hand-driving power.

The gradual raising of the fork to the unlocking-wheel of the main arbor of the clock-train raises the guard-lever, on the rests of which the spring-arm of the pinion lies, until, at a point near the highest limit of motion of this lever, the spring-arm is released, and transferred to the guard-plate at the opposite lower end of the lever. The dropping of the fork to the next tooth at the moment of arriving at its highest point carries the lower guard-plate rapidly in an upward direction, which motion liberates the spring-arm, and produces by the action of the turret power the complete motion of the revolving pinion and the spring-arm, until the latter is again arrested by the stops of the guard-lever.

The arbor to which the revolving frame is attached communicates by a pinion with an intermeshing wheel, attached to the main arbor of the turret-weight. This gears again, by an outer bevel-wheel, with

a bevel-wheel attached to the vertical shaft for transmitting the motion to any height in the tower. Simultaneously with the revolution of the pinion the arbor of the hand-driving weight, being free to move, transmits motion to the vertical shaft and to the hands, so that they are moved forward the proper distance on the dials. Any interruption of the regular motion of the hands by ice or snow, or by the breaking or injury of one of the intermediate parts, arrests only the regular working of the hand mechanism, without affecting in the least the clock-train. This continues its regular course, and thus is secured for the clock a freedom from repairs and supervision, and a reliability and accuracy of performance, which could not be obtained by the direct working of the dials from the clock-train in the usual manner.

The great dials for indicating the time may be placed at any distance above or below the clock-train and turret-clock mechanism, and hence it may occur that on account of the length of the vertical shaft a considerable weight will have to be overcome. This is accomplished by suspending the shaft from a carriage that revolves on a platform at the height of the centre of the dials. If the time is to be indicated on another set of dials below the clock, as is found very useful in many cases, either a separate shaft is suspended in connection with the main arbor of the hand-driving machinery, and operated thereby, or an extension of the same shaft, supported by another carriage and platform, is provided to facilitate the transmission of motion to the lower dial hands. Bevel-wheels at the extremity of the vertical shaft transmit finally the motion to the minute hand, and in the usual manner this controls also the hour hand. There is also provision made by which the hands of the great dials may be easily set to correspond with those of the controlling clock whenever, on account of the temporary derangement of the turret machinery, or from other causes, it may become necessary to do so.

The greater the number of hands and dials employed for indicating the hour at various heights of the tower, or in various stories of a building, the greater in proportion has to be the power of this part of the machinery, while the size of the clock-train is not increased; so that the latter may be constructed with all possible delicacy, and in a compact form; and besides, it may be put up at any convenient part of a building or tower.

The accounts rendered of the performance of some of these clocks in actual use are very satisfactory; and besides, the convenience of the arrangement, as well as the relative cheapness at which they are constructed, are positive recommendations in their favor.

HADANK & SON, *Hoyerswerda, Germany.*

A tower clock and bell. The clock was in compact form, and of good workmanship throughout. It has the ordinary dead-beat escapement, and hence, considering the difficulties to be encountered in the case of clocks of this size, it cannot be expected to perform as well as those which have already been described. The bell is of excellent composition, and the casting apparently perfect.

LOUIS H. SPELLIER, *Doylestown, Pa.*

A large clock with four dials, which was well made. It had lantern pinions and the ordinary form of pin-wheel dead escapement. The pendulum, with mercurial compensation, was suspended by two springs which passed over friction-rollers, the object of the arrangement being to bring the pendulum back speedily to its proper plane of vibration in case of any disturbance. This is too complicated, and besides, it introduces sources of error too considerable to be neglected. It is not therefore to be recommended; but the workmanship throughout was considered worthy of commendation.

II. ASTRONOMICAL CLOCKS.

The number of first-class astronomical clocks exhibited was small, but there were nevertheless some specimens of excellent workmanship. Those exhibited were of the ordinary form, with Graham's escapement, and with mercurial or zinc and steel compensation.

A. HOHWÜ, *Amsterdam, Holland.*

This pupil of the celebrated Kessels exhibited an astronomical clock of excellent workmanship throughout. The clocks by this maker have shown the best results when subjected to actual trials in an astronomical observatory. One of them has been in use for several years in the observatory at Leyden, and has received the highest commendation from the officers of that observatory. Those who are acquainted with the performance of standard clocks in astronomical observatories, where accurate time-keeping is of the first importance, will understand better than the generality of clockmakers even what may be expected in reference to the performance of such instruments. The theoretical method of construction being well established, the choice of a clock must depend upon the skill of the maker in producing that delicate and accurate workmanship which is necessary in order to reduce the errors of its performance to a minimum.

In the discussion of the observations made at Leyden, the clock under consideration, Hohwü No. 17, was not disturbed in any way, except from climatic changes, for a period of two years and a half, and during this interval its temperature was subject to a considerable range. The mean daily rate at the beginning and end of this period differed only a few hundredths of a second. It was found that its daily rate could be computed almost exactly by the following formula:

$$\text{Daily rate} = -0.339^s + 0.0174^s\,(10^\circ - t) - 0.011^s\,(760^{mm} - b),$$

in which t denotes the reading of the thermometer in degrees of Réaumur's scale, and b that of the barometer expressed in millimetres. Subsequently, after the lapse of a considerable interval of time, a second series of observations was made, extending through twenty-eight months, the discussion of which gave the following formula for the daily rate:

$$\text{Daily rate} = -0.339^s + 0.01885^s\,(10^\circ - t) - 0.01269^s\,(760^{mm} - b).$$

The comparison of this result with that obtained from the first series shows that the co-efficients which express the effect of heat and atmospheric pressure upon the rate of the clock had changed slightly, while the normal rate for the temperature, 10° Réaumur, and the barometer at 760 millimetres, had remained unchanged. This seems to prove conclusively that the normal rate of this clock was not affected by the climatic changes to which it was subjected. Other clocks by the same maker, subjected to rigorous trials, have given similar results. The co-efficients for temperature were always very small, and of course different for the different clocks, but the barometric co-efficients showed in every case a remarkable agreement.

CHARLES FRODSHAM & Co., *London, England.*

Several fine clocks, one of which had a pendulum vibrating every two seconds. These clocks were finished in the manner characteristic of their work, the excellence of which has given them a world-wide reputation. There are many of their astronomical clocks in use in observatories in different parts of the world, and, although the reporter has not at hand any elaborate discussion of observations to indicate their running qualities, it is at least certain that the results have been wholly satisfactory.

JOHN LINDEROTH, *Stockholm, Sweden.*

A fine clock, with Graham's escapement and mercurial compensation, the finish of which was of a high order. Mr. Linderoth is considered to be the most skillful maker of clocks in Sweden, and,

so far as could be determined without an actual trial, the clock exhibited clearly enough attested his skill.

GUSTAV BECKER, *Freiberg, Silesia, Germany.*

An astronomical clock with zinc and steel compensation, in a mahogany case with marble base, the price of which was quite reasonable for a clock so well constructed. The style and finish were quite like clocks by Tiede, of Berlin, which the reporter has seen.

JOHN L. GROPENGEISSER, *Philadelphia, Pa.*

A clock constructed by himself. It had lantern pinions, and the pallets were in the pendulum-rod itself, thus obviating the necessity of anchor-pivots. There is nothing in the way of novelty in this construction. The workmanship was of a high order, but it was impossible to determine the character of this clock as an instrument of precision without an actual trial such as could not be made during the Exhibition.

III. REGULATORS AND CLOCKS FOR COMMERCE.

There is a class of clocks constructed in accordance with approved methods, and with approved forms of escapements, which are often quite well finished, and which are supplied with pendulums in a greater or less degree compensated for changes of temperature. They are intended for use in counting-houses, railway-offices, and other places where accurate time-keeping is desired, but not in the sense in which it is applied in the case of astronomical observatories for the purposes of astronomical observations. Such clocks are those, too, which most of the jewelers and watch-repairers use as standard time-keepers, and hence they are known as regulators. There are many such in use which ill deserve any such appellation. Very often there is no real attempt to compensate for temperature. It is true that the pendulum-rod is made of alternate rods of brass and steel, for the sake of show, and in imitation of the gridiron pendulum, but there is no actual provision for compensation, and, so far as the time-keeping properties are concerned, it would have been vastly better if the pendulum-rod had been made of wood, and, if necessary in order to disguise the character of the clock, concealed by a closed case. The reporter has seen many clocks with good movements, dead escapements well finished and duly adjusted, and even jeweled holes for the anchor-pivots, which had this mock compensation. As might be expected, among the clocks of this class at the International Exhibition there were all grades to be found, from those which were

almost sufficiently well constructed to be used as instruments of precision to those which could scarcely rank with some of the specimens of clocks of commerce for ordinary use. It is not necessary to consider them separately, whatever the excellence or defects of their construction, since they were exhibited with other clocks of inferior grades by the same makers, and hence they are here classed under a common head with the clocks of commerce.

AMERICAN CLOCKS.

The manufacture of clocks in the United States has become a distinctive branch of our industries. The use of stamps to cut from plates of brass the frame and the wheels of the train, as well as other parts, and the use of lantern pinions, the whole made with cutters which are of proper form, has enabled our clock-makers to produce what are known as American brass clocks, of a quality sufficient for the ordinary purposes of house clocks, and at a price so low as to open for them a market in every country of the globe. Numerous specimens of this manufacture were shown at the Exhibition. Among those whose productions were shown were the SETH THOMAS CLOCK COMPANY, *of Thomaston, Connecticut;* E. M. WELCH & Co., *of Forestville, Connecticut;* the NEW HAVEN CLOCK COMPANY, *of New Haven, Connecticut;* and the ANSONIA BRASS & COPPER COMPANY, *of Ansonia, Connecticut.* These clocks were of every style and size, from a regulator with seconds pendulum to a small marine clock with lever escapement, and power communicated to the train by a spring. The parts of the movements of many of them were nickel-plated. The majority of them had striking attachments, and often, too, there were calendar attachments. These clocks are constructed upon a uniform plan, with interchangeable parts made by machinery, and the rivalry of the manufacturers is almost wholly in the direction of cheapness of production. This has indeed reached a point which, considering the relative qualities of the various productions, leaves scarcely anything to be desired. In addition to good trains for movements to be sold at so low a price, these clocks were placed in well-finished, durable cases.

THE ITHACA CALENDAR CLOCK COMPANY, *Ithaca, N. Y.*

A great variety of calendar clocks. The clock movements are constructed for them in accordance with their patterns by E. N. Welch, at Forestville, Connecticut, and their work consists in the attachment and adjustment of the calendar-indicator. The parts of

the clock movement are cut out of unusually thick sheets of brass, and all the main holes are bushed. The escapements are all dead-beat, whatever the grade of the clock, and the parts are all interchangeable for the same size of movement. The calendar attachments are simply arranged, and the accuracy of their performance, corresponding to a period of eight years of running of the movement in regular use, is tested by a machine constructed for that purpose. This company is enabled to produce calendar clocks of good quality for general use at very moderate prices indeed.

E. PAULUS, *Philadelphia, Pa.*

An escapement of his invention, to be used for what are called traveling clocks. It is the ordinary chronometer escapement, modified first by placing the locking-spring at right angles to the passing-spring, and then a scape-wheel, to communicate the impulse at right angles to the direction of the ordinary form. This avoids the use of a change-wheel to alter the direction of the motion, as in the case of the usual form of construction, and as in the case of the cylinder escapement in watches.

J. W. HILE, *Waterville, Kansas.*

A "century clock," so arranged, as the exhibitor declared, as to run a hundred years without rewinding. Mr. Hile's clock had for a pendulum a horizontal disk, moved by the torsion of a long steel spring. The escapement was very ingeniously constructed, and was entirely detached, except when communicating the impulse. The workmanship was very creditable indeed, and while it is true that by his arrangement the minimum of weight to move over a given distance for a long period before rewinding was secured, yet, unfortunately for his system, the sources of error are such that the requisite accuracy of time-keeping is not secured. Clocks have frequently been made in which the motion was regulated by the vibration of a torsion-balance, although, so far as the reporter knows, Mr. Hile is entirely original in the mode of communicating the impulse and unlocking the train of wheel-work. By having a very long spring the motion of the balance becomes very slow, and the intervals between the successive impulses and motion of the wheel-work of the clock very long. He was very confident that his clock would exhibit the time with considerable precision. An actual trial, however, gave very unsatisfactory results. The mounting of the clock, as set up at the Exhibition, was very unstable, and it was not possible to determine what proportion of the irregularities of its rate might be due to that

source. Still, it is beyond question that this form of construction, like that of the conical pendulum, will not answer for a clock to be used as an instrument of precision.

B. H. BACON, *Philadelphia, Pa.*

A "lunar clock." It was an ordinary clock, with a lunar calendar attachment, but contained no novelty to be specially mentioned.

SILAS FOURNIER, *New Orleans, La.*

A clock with striking attachment, to be used in giving signals for the starting of trains from a railway station. By means of a system of levers controlled by the clock-train, strokes were made upon different bells at regular intervals, and by giving in each case a different number of strokes, the signal for starting different trains would be made. This system would be very convenient in the central stations of street railways, where cars are to be started at short intervals and upon different lines, and where regularity is desired. The same clock contained a device to indicate the presence of watchmen at appointed hours.

MITCHELL, VANCE, & CO., *New York, N. Y.*

A collection of clocks, nicely mounted in bronze or spelter cases. The movements were constructed for them at Forestville, Connecticut, and are of the better class of cheap brass movements. The mounting was in good taste, and, in some instances, quite elaborate in design.

LEFORT & CHAPLEAU, *Montreal, Canada.*

A clock arranged to be used as a watchman's detector. It consisted of an ordinary clock, with a wheel or plate in front, on which the hours were marked. A knob on the outside of the case below connects with a series of pins, which may be pulled out, one every quarter of an hour. The arrangement is cheap and simple, and doubtless sufficient for the purpose of its construction.

CYRILLE DUQUETTE, *Quebec, Canada.*

Another watchman's detector, similar to the preceding. A series of arms is arranged, four to each hour, and, by means of a rod, one may be pulled out as it passes. This attachment may be readily applied to any clock.

IMHAUSER & Co., *New York, N. Y.*

This watchman's detector consists of a large watch movement and a device attached, by which a permanent record is made of the times when the watchman visits certain points of his beat. There is a series of twelve keys, different for each watch, each of which is kept in a designated locality, to be visited by the watchman, and by means of which he punches a paper dial (to be changed daily), showing exactly when he is at the place of each key. There is also a safety attachment to each lock, so that if the watchman has a key to open the watch, a mark is punched on the paper dial, showing that this has been done.

ENGLISH CLOCKS.

There were only two English makers who exhibited clocks, but they were representatives of the highest achievements of the art in that country.

M. F. DENT, *London.*

Some very beautiful clocks for the mantel. These had what is known as the chronometer escapement, with fusee and train, as in marine chronometers, the whole well finished and adjusted for action with great delicacy. He exhibited also clocks with lever escapements and flat spiral balance-springs.

CHARLES FRODSHAM & Co., *London.*

Parlor and ornamental clocks, in addition to electrical and astronomical clocks. They all showed evidences of exact workmanship such as characterizes the productions of this house.

FRENCH CLOCKS.

There were exhibited a considerable number of the well-known French clocks, and in great variety of styles. The celebrated house of BRÉGUET, *Paris*, exhibited some very fine specimens, not only in respect to workmanship in the construction of the movement, but also in respect to the decoration and style of the case.

E. ROSSET, *Paris.*

Clocks with the movements concealed in the arbor of the hands, showing a large dial and hands in the usual way. These naturally attracted the curiosity of the visitors, the concealment being very complete.

B. BONTEMS, *Paris*.

Beautiful specimens of ornamental clocks with artificial singing-birds.

BOUCHER-GRAVET, *Paris*.

A variety of clocks, which were noticeable particularly on account of their being cased in antique styles, and for the very beautiful decoration of the cases.

EUGÉNE FARCOT, *Paris*.

A variety of clocks of different grades, adapted to the general purposes of commerce, into many of which he has introduced novelties, interesting and convenient. Among others was a large clock with a conical pendulum, duly compensated. There were also clocks for ships, with an arrangement for rewinding, invented by Mr. Farcot, and patented in the United States. There are two spring barrels, one of which winds the clock, while the other winds up again the cord. There were also clocks of different sizes, with conical pendulums, as well as a collection of very simple, efficient alarm-clocks. The entire exhibit was worthy of commendation for the variety and excellence of the productions, when the purposes of the manufacture are considered, and for the very moderate prices at which they are furnished.

SÜSSFELD, LORSCH, & CO., *Paris*.

A collection of common grades of French clocks, in marble, showing a variety of designs.

MAYET-TISSOT, *Morez (Jura)*.

Three regulator clocks. One of these had brass and steel compensation, and a large, flat pendulum ball, with metallic thermometric indicator. It had a calendar attachment, showing the days of the week and month, and the phases of the moon. It also had a pointer, to indicate the equation of time. The workmanship appeared to be excellent, but there was no opportunity to test its time-keeping properties. He exhibited, also, two regulators, with well-finished movements, and seconds pendulums, with mercurial compensation.

MEUBLEY & VERDIER, *Paris*.

The purpose of this device, which was exhibited in the Machinery Hall, is to indicate time or distance in connection with cabs or coaches for hire in cities. It shows by a dial and pointer, for the tariffs fixed, the amount of hire which has accrued at any instant, and also the

time elapsed and the distance traversed. It marks also upon a fillet of paper the distance passed over. The movement-indicator is in relation to time controlled by a clock movement, and in relation to distance by air compressed in a flexible tube, connected with a bellows and ratchet and wheel-work, and operated at each revolution of the carriage-wheel. This indicator is compact, easily understood, reliable in its indications, and durable.

GERMAN CLOCKS.

The Black Forest region of South Germany has long been famous as the place of manufacture of the cheap wooden clocks which are in use in many countries. The movements of these clocks, it is well known, are about as bad as can be constructed, but nevertheless the ornamental cases of wood, carved with great ingenuity, and the attachment of an artificial singing-bird, or some similar device, in connection with the striking of the hour, has kept up the demand for them as toys long after they ceased to be sought after for the purposes of marking the hour. It must not, however, be supposed that a good article of house clocks is not made in that country. Even the makers of the cheap wooden clocks make also better grades, and the total production of all kinds is the greatest of any country, excepting only the United States. This industry has flourished in that part of Germany for two centuries, and it bears the same relation to clock-making for the purposes of commerce that Switzerland does to watch-making. The annual production is stated to be about 1,800,000 clocks, of the value of nearly $4,500,000. About 14,000 persons are engaged directly or indirectly in the manufacture of clocks in the Schwarzwald, of which more than 1400 are established clock-makers or manufacturers. The system adopted is that of the minute division of labor, with only a very limited use of labor-saving machines.

GUSTAV BECKER, *Freiburg, Silesia.*

His astronomical clock has already been mentioned. He also exhibited a large collection of clocks of various grades, which were, on the whole, the best of the German exhibits in this particular department of horology. His clocks are made on the plan of the interchangeability of the parts; and in addition to finished clocks he exhibited a large collection of parts of clocks and of well-finished movements.

CONRAD FELSING, *Berlin.*

A collection of clocks for the ordinary purposes of commerce, some of which were very well mounted in imitation bronze cases.

It was understood, however, that the clock movements were manufactured in Baden.

The chief collection was exhibited by nine manufacturers, who put their productions together as a single exhibit, under the title of "KOLLEKTIV AUSTELLUNG SCHWARZWÄLDER UHRMACHER." These were:

1. AKTIEN-GESELLSCHAFT FÜR UHRENFABRIKATION, *Lenzkirch.*
2. BENED. SCHWER, JR., *Triberg.*
3. PH. HAAS & SÖHNE, *St. Georgen.*
4. EM. WEHRLE & CO., *Furtwangen.*
5. LEO KALTENBACH, *Furtwangen.*
6. B. KETTERER SÖHNE, *Furtwangen.*
7. LORENZ BOB, *Furtwangen.*
8. MAURER & HÖFLER, *Eisenbach.*
9. J. BAPT. BEHA & SÖHNE, *Eisenbach.*

The united collection gave a great variety of sizes and styles of finish. The movements were well finished for the particular grades of clocks exhibited, which were principally of the grade known as "Schwarzwälder Uhren." Among them were regulators with well-finished trains and escapements, but with wooden pendulums, made respectively by L. Kaltenbach, L. Bob, and B. Ketterer & Sons; also regulator clocks, with well-finished movements and compensated pendulums, by Maurer & Höfler, and the Aktien-Gesellschaft. The exhibit contained, also, three trumpet clocks, by Em. Wehrle & Co., worthy of special mention. There was also a large number of what are called cuckoo clocks, with elaborately carved cases. The reader not familiar with these designations will understand that they refer to the musical attachments connected with the striking parts, by which a trumpeter performs on his instrument, or a cuckoo comes out and sings, as the hours are struck. What is worthy of notice in respect to these productions is their cheapness, when the labor necessarily expended is taken into consideration.

MAURER & HÖFLER, *Eisenbach.*

A regulator clock, with brass and steel compensation, in an elaborately ornamented case. They exhibited, also, a watchman's clock, of simple construction.

CARL & LUDWIG HAAS, *St. Georgen.*

Cottage and octagon clocks, with brass movements, constructed upon the American plan.

SWISS CLOCKS.

There were only two exhibitors of clocks from Switzerland, and of these only one contributed articles which came under the examination of the Judges on horological instruments.

LEUENBERGER & SON, *Summiswald, Berne.*

There was one regulator clock, with compensated rod, and two clocks for ordinary use, constructed in the Swiss fashion. The workmanship was good.

M. HIPP, *Neuchâtel.*

Electric clocks, the performance of which fully corresponded with his reputation as an accomplished manufacturer of instruments of precision for the keeping or registration of time. The particular examination of these clocks was assigned to the Judges upon Electrical Apparatus.

IV. MARINE CHRONOMETERS.

The number of marine chronometers exhibited was such as to give a correct idea of the condition of this manufacture in the different countries whose productions were on exhibition. This instrument in its most perfect form has resulted from the demands of navigation, and upon its performance the safety of commerce in a large measure depends. As an instrument of precision it is entitled to the highest rank, and especially when it is considered that, unlike in the case of an astronomical clock, it is not almost daily compared with actual time observations to determine its error and rate, but, on the contrary, it is to be depended upon for weeks and even months, and the time observations are solely to find the local correction, and hence the longitude at sea.

The method of construction has long been well established, and the only differences usually to be found in the work of different makers, beyond minor differences in the arrangement and size of the parts, are in respect to the adjustment for temperature. The isochronism of the action of the balance-spring is of the first importance, and this adjustment has, ever since the chronometer has been depended upon to find the ship's place at sea, received the most careful attention from the makers of these instruments. This adjustment is well understood, and is not difficult to effect within moderate limits, especially since there is provision made that the instrument shall perform its functions always in the same position. The chief diffi-

culty is in the correction for temperature, and it is to accomplish this that many devices have within the last twenty or thirty years been proposed and applied. The use of the simple bi-metallic rim of brass and steel was for a long time considered to be sufficiently exact, and there are many reputable makers who still adopt the simple compensation. But it is well known that even if it be desired to compensate for the principal effects of temperature, such as those resulting from the change of the dimensions of the balance itself, and the change in the length of the balance-spring and in its elastic force, the action of the laminæ in changing the position of the compensating weights cannot provide exact compensation over a considerable range of temperature, because the law of variation in the one case is not precisely the same as in the other. Hence there will be two points, or temperatures, at which the compensation may be perfect, but at other temperatures, on account of the irrationality of the compensation, there will be outstanding differences, which must be provided for in some other way. And further, when an extreme limit of precision is sought, the nicest adjustment of the isochronism of the balance-spring becomes complicated with the temperature error, so that a limit is reached beyond which we can hardly expect to progress. It is easy to understand the principal part of the secondary error, and it is not difficult to provide for it to a considerable extent. All of the devices for auxiliary compensation which have been used, and so frequently described as to require no particular description here, do reduce the secondary error very much, but they do not remove it entirely. It has been suggested that it is of little importance to attach a mechanical device to the balance to provide for this error, which, by the irregularity or uncertainty of its action, may be the source of other mischievous errors, whose existence even would not be suspected in the absence of actual time observations for comparison, when the law of the irrationality of the compensation may be determined for each chronometer in actual use, and the proper corrections to be applied to the rate tabulated for each degree of the thermometer. Various formulæ have been proposed for the calculation of these errors, and, as might be expected, when the numerical constants have been determined for any particular chronometer, a close approximation to its actual rate at a given temperature can be made. That the law is approximately known is shown clearly enough by the circumstance that a single formula may be applied to a great number of chronometers similarly constructed. Still, there can be no question that when an extreme limit of precision is sought, the mathematical expression of the law of the residuals would be different for each chronometer;

and if this method is to be depended upon solely, a thorough discussion of an extended series of comparisons with an accurate standard should be made, for the purpose of determining the particular formula and the values of the constants. Such an investigation ought to include conditions for determining outstanding errors of isochronism at different temperatures, and for different degrees of viscosity of the oil. The inherent difficulties of the problem, and the actual demands of those who are to use the chronometers, are such that it has become desirable to provide a mechanical correction which, while not giving results of the greatest possible accuracy for a particular instrument, is yet sufficient for the actual necessities of the case. This avoids, too, the necessity for a continuous and frequent thermometric record, which is indispensable when the secondary correction is to be computed or derived from a table previously prepared.

Nearly all the chronometers exhibited had some such device, and in the absence of conclusive trials of the accuracy of the performance of each, it was often necessary to judge of the plan by a simple inspection of its construction, assuming that a skillful maker could effect the actual adjustments necessary.

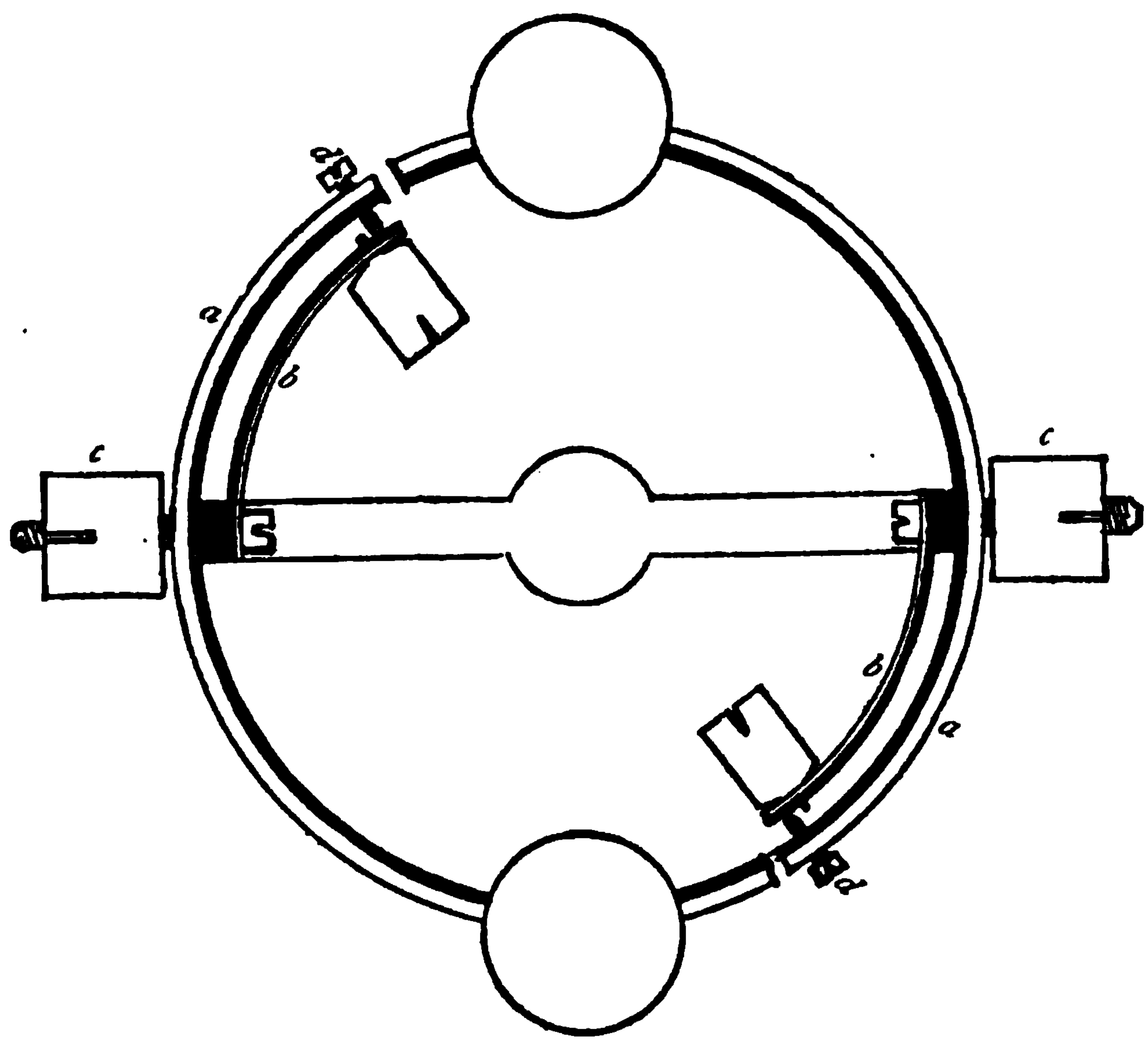
AMERICAN CHRONOMETERS.

Specimens of the work of the two principal American manufacturers of marine chronometers were shown at the Exhibition. Of these, Messrs. John Bliss & Co., of New York, alone entered chronometers for competition for an award, and the exhibit made by this house will first be considered.

JOHN BLISS & CO., *New York, N. Y.*

It is usual for American manufacturers to import the *ébauche* from England, and the work performed by them consists in finishing up the parts of the train, and in making the adjustments for isochronism and temperature, upon which the time-keeping properties depend. Messrs. Bliss & Co., however, exhibited chronometers which had been wholly constructed by them, and hence of strictly American manufacture throughout. One of these was taken down, and all its parts minutely examined by the Judges, and the result was that the workmanship was found to be excellent in the case of every part. All the necessary conditions for smooth action of the train were completely satisfied, and it remained only to make actual timing test in order to determine whether the requisite adjustments of the balance and of the balance-spring had been attended to. The compensation for temperature was made in the usual way, with an additional

contrivance to provide mechanically for the irrationality of the compensation, and since the device used is as simple and efficacious as any which have been proposed, its description will not be out of place here. By reference to the figure it will be readily understood.



JOHN BLISS & CO.'S AUXILIARY COMPENSATION.

The main compensation is that usually employed,—brass outside, steel inside. It is, however, cut apart somewhat farther from the arm than ordinarily in order to give a sufficient length to the laminæ *a*, *a*. Auxiliary laminæ, considerably thinner than those of the main compensation, and with the brass inside and steel outside, are provided at *b*, *b*, which are secured by means of the steel screws which pass through the feet left on the auxiliary laminæ and the rim of the balance, which screws also hold the mean time regulating nuts *c*, *c*, as usual. At *d*, *d*, are provided small steel check-screws, passing through the laminæ *a*, *a*, their points just touching the auxiliary laminæ.

To understand the action of the auxiliary, it is necessary to keep in mind the operation of the ordinary compensation in different temperatures. If such a balance be adjusted so that its rate will be mean time in the temperatures of 100° and 40° Fahrenheit, it will gain about three seconds daily in the intermediate temperature of 70°, which amount is a fair average for this intermediate error, which is seldom found to be as small as one second, while it is often as much as six seconds in the daily rate. If the same balance be adjusted, so that

its rate will be mean time in 100° and 70°, at 40° it will lose about six seconds daily. If adjusted to mean time in 40° and 70°, it will lose about the same amount at 100°. Leaving out of question the cause of this, it is evident that the compensation weights move out from the centre of the balance too much in cold, and that they do not move inwards sufficiently in heat. What is required is to lessen the effect of the compensation in cold and increase it in heat. This is effected with this auxiliary balance, as follows: When the temperature is raised to 100°, in addition to the inward movement of the main compensation, the laminæ *a, a,* press on the weaker ones *b, b,* and overcome the tendency of the latter to move outward. Therefore all the compensation weights move inward. With a decrease of temperature to 40°, the main compensation moves outward; but now, while the laminæ *a, a,* move outward, carrying no weight but their own and the small check-screws *d, d,* the laminæ *b, b,* move inward, the movement of their weight-screws counteracting a portion of the effect of the main compensation.

The auxiliary compensation most frequently used differs from this in having a rigid steel segment screwed to the arm, and concentric with the centre of the balance. On the inner side of this segment a similar auxiliary is attached, and the rest of the construction is the same as that above described. There is, however, this difference in the action: When the temperature is decreased to 40°, the segment does not change its shape, the auxiliary laminæ only moving inward to effect separation. If, therefore, the auxiliary laminæ spring slightly against the point of the check-screws, or there is, from long contact, a slight adhesion of the parts, there is not that sudden and decisive separation that takes place in the form first described, and no action of the auxiliary until it does take place. Besides, the segment is one more part to make, while the compensation pieces *a, a,* are already part of the balance, and, when the segment is attached, make an additional joint, of which there should be as few as possible in a chronometer balance.

The chronometers made by Messrs. John Bliss & Co. have long maintained an excellent reputation, derived from their reliable performance at sea, as well as in observatories. It would, therefore, seem unnecessary to have attempted a trial at the Exhibition; but, confident of the superiority of their productions, they were anxious to have the chronometers submitted to rigorous trials. This could not be done to an extent sufficient to test the action of the auxiliary compensation at many different temperatures, or even at the proper extreme and middle temperatures; but, the requisite astronomical instruments

being in position as a part of the exhibit made by the United States Government, it was possible to make a trial sufficient to indicate the merits of these chronometers. Accordingly, it was undertaken, and the reporter has to regret that the arduous duties devolving upon him in the examination of so many different exhibits in the limited time allotted made it impossible to make as extended a trial as he desired. There being no astronomical clock in position in connection with the transit instrument, the time was carried from one observation to another by means of four excellent chronometers not under trial, and hence kept undisturbed, and at a temperature as uniform as possible. The chronometers exhibited by this house being all similar in construction, and all apparently equally well finished, four only were subjected to trial in connection with those of other makers. These were numbered 2716, 2768, 2769, and 2770. The trials extended only through eight days, and the several results are shown below. To determine whether the adjustment for the isochronal action of the balance-spring in long and short vibrations was properly made, the mainsprings were set back two turns and a half, and then the chronometers were wound to 12*h*., as shown by the indicator on the dial. The balances were now moving through short arcs, and the rates thus found, compared with the rates in long arcs when the tension of the springs was restored to its normal arrangement, and the chronometers wound up, indicated the character of the isochronal adjustment of the balance-springs. For temperature, they were kept 48 hours in a refrigerator and 48 hours in a heated room, and the rates found at the extremes, in connection with those in the middle temperature, show, in a degree, the character of the compensation, although not as fully as the reporter desired to make the test and as the excellent instruments under trial deserved. The results of the comparisons are shown by the following table:

Period.	Balance vibrating in	Average Temperature.	Daily Rate of No. 2716.	Daily Rate of No. 2768.	Daily Rate of No. 2769.	Daily Rate of No. 2770.
		°	s	s	s	s
1876. July 27 to July 29	Short arcs	75	+2.89	+0.95	—2.59	—0.80
" 29 " 31	Long arcs	72	+0.92	—1.55	—0.22	+1.38
" 31 to Aug. 2	Cold	38	+1.72	—0.12	+0.24	+3.61
Aug. 2 " 4	Heat	88	+0.44	—0.78	+0.45	+1.45

When the trials began the mainsprings were set back so as to act with greatly-diminished force, and hence the balances vibrated through very short arcs. After having run in this manner for two days, the springs being set at their proper tension and wound up, the balances again moved through long arcs of vibration. The differences of the

rates thus found show the outstanding errors of the adjustments for isochronism. Thus we have:

Chronometer.	Difference between Long and Short Arcs.
	s
No. 2716	−1.97
No. 2768	−2.50
No. 2769	+2.37
No. 2770	+2.18

The smallness of these errors shows the excellence of these adjustments. It will be observed further, that in the case of two of these chronometers the acting parts of the balance-springs were too short, while in the case of the other two they were too long.

The trials for temperature errors, although sufficient to show that the compensation was well made, yet do not indicate fully the effect of the secondary or auxiliary compensation. On account of the lack of necessary facilities the rates at the proper middle temperature could not be determined, and the reporter does not know what the critical temperatures were for which the adjustments for compensation were originally made. Still, it is clear beyond question that the secondary error is very much reduced by the auxiliary compensation. The adjustments of chronometer No. 2769 appear to be closer than those of the others, although all of them are far within the limits recognized as the proper standard for first-class marine chronometers.

While it cannot be urged as an objection to a particular chronometer that the different parts were manufactured by different persons, provided that the adjuster has finally performed his duty, it is nevertheless certain that when the whole has been constructed at a single establishment it furnishes evidence that the maker is familiar with all the details of the manufacture. As already stated, the chronometers exhibited by Messrs. John Bliss & Co. were wholly of their own manufacture, and a critical examination failed to reveal any defects of construction or of details of workmanship. On the contrary, the whole execution was found to be of a character such as to entitle them to the highest commendation. The records of the performance of their instruments upon long sea-voyages were also carefully examined, and these thoroughly established the fact that they were fully as good as those of the most renowned makers in other countries, where this industry has kept pace with the most exacting demands of navigation.

T. S. & J. D. Negus, *New York, N. Y.*

In the United States Government Building, as a part of the Naval exhibit, Messrs. T. S. & J. D. Negus, of New York, exhibited several

marine chronometers. This house furnishes the chronometers required by the Government, and, besides, has long had an established reputation in connection with the mercantile marine for the excellence of the instruments sent out. On account of the regulations in respect to the exhibits entered for competition, these chronometers could not compete for an award, but are entitled to proper mention in this general report. Two of them, numbered respectively 1447 and 1595, were subjected to trial in connection with the other chronometers under examination, and under precisely similar circumstances, and the results were as follows:

Period.	Balance vibrating in	Average Temperature.	Daily Rate of No. 1447.	Daily Rate of No. 1595.
		°	s	s
1876. July 27 to July 29 . .	Short arcs	75	—1.42	—1.01
" 29 " 31 . .	Long arcs	72	—0.57	—1.25
" 31 to Aug. 2 . .	Cold	38	+2.91	+0.66
Aug. 2 " 4 . .	Heat	88	—0.15	—1.08

The difference of the rates for long and short arcs, was, therefore, + 0.85^s for No. 1447, and —0.24 for No. 1595, thus showing that the adjustments for isochronism were exceedingly well made. The balances had simple compensation, and the outstanding temperature errors were shown to be very small. Sometimes it has happened in trials extending over a long period that the simple compensation has given results fully as accurate as those for the cases where the auxiliary compensation has been applied. In general, however, such is not the case, the exceptional results being due to other compensating causes. Hence it may be suggested that the excellent instruments of Messrs. Negus would be still further improved by this additional precaution against errors due to changes of temperature, especially for the reasons already mentioned as resulting from the requirements of navigators, who rely directly upon the indications of these instruments.

Some of the chronometers exhibited by Messrs. Negus were adapted to the purposes of astronomical observations with the electro-magnetic method of recording the times of transits of stars or of other observations. They were provided with break-circuit attachments. The wheel-work of the chronometer is made to break a metallic circuit at the end of each second by means of a wheel of sixty teeth acting on a jewel pallet attached to a light steel spring, the spring having a platinum screw in it, and the head of the screw banking on the point of another platinum screw projecting through a fixed insulated stud connected with terminals on the outside of the chronometer. The electric circuit is interrupted for a period of about one-fortieth of a

second while the platinum points are separated by the action of the wheel upon the jewel pallet. The motion of the balance of the chronometer is not disturbed in the least by the passage of the electric circuit, since the breaking of the circuit is performed by a supplementary wheel having no connection with the escapement. The arrangement of a break-circuit attachment, such as that just described, in connection with marine chronometers, has been made by many other makers, but Messrs. Negus were the first to employ in connection a condenser, to prevent the production of an electric spark at the platinum points as they are separated in opening and closing the circuit. The advantage of this is obvious. Not only is the deflagration of the platinum points prevented, so as to insure continuous action of the break-circuit, but any irregular adhesion is prevented, so that the force employed in the action of the break-circuit wheel is constant, and hence produces no change of the rate, whether the chronometer is actually breaking an electric circuit or not. The condenser is constructed of alternate layers of paraffine-paper and tin-foil arranged in two distinct series insulated from each other, and each series is attached to the terminals on the outside of the chronometer. The reporter has had actual experience with the break-circuit chronometers made by Messrs. Negus, with the condenser for arresting the spark applied, and he can bear testimony that their performance as time-keepers, as well as the certainty of the action of the break-circuit attachments, have been all that could possibly be desired.

E. PAULUS, *Philadelphia, Pa.*

This manufacturer exhibited a marine chronometer movement, and also a hand model of the escapement, constructed by him. There is a fork like that in the lever escapement, while the other extremity of the lever is geared into a pinion. The arbor of this pinion has, on the upper side, a notch in which the teeth of the scape-wheel rest. The impulse is given by a pin on the roller acted upon directly by the scape-wheel. The fork and the balance are moving in the same direction when the impulse is given. The performance of this movement as an instrument of precision had not been subjected to any critical test, and it was not submitted to trial at the Exhibition.

ENGLISH CHRONOMETERS.

The English chronometer-makers have long been known throughout the world as occupying a high rank in the profession. It was in that country that the marine chronometer, as we have it at the present day, had its origin. The liberal reward offered by the British Parlia-

ment, more than a century ago, for the discovery and application of a method of finding the longitude at sea within limits demanded by the necessities of navigation, led to the production of the first instrument of this kind which could truly be called an instrument of precision. Although its performance was such as to secure the promised reward, the limits within which the determination of the longitude must lie being exceedingly liberal, from the present stand-point of science, yet it was far from being such an instrument as would pass muster at the present day. The immense mercantile and public marine of Great Britain has given employment to a large number of skilled workmen in the construction of the necessary chronometers, and, besides, the regular trials at the Greenwich Observatory of a large number of these instruments, from the most successful of which the Admiralty selected those required for the navy, have served to stimulate the makers to the production of the very best possible specimens of their work. As might be expected, all that could be derived from scientific construction and exquisite workmanship has been achieved, and the annual records of the trials made at the astronomical observatories show a steady approach towards greater perfection.

The attention of the English makers has been chiefly directed, of late, to the perfection of the compensation for temperature effected by the balance, and, as a consequence, a large number of ingenious contrivances have been proposed and executed. One of the exhibits, that of Messrs. Charles Frodsham & Co., of London, contained a collection of all the varied forms of balances with auxiliary compensation which had been tried by them since this subject began to receive special attention. The study of this collection was very interesting, and it served to convey in a very forcible manner the nature of the difficulties which the successful chronometer-maker has to encounter.

The trials of marine chronometers, made at the Greenwich Observatory, extend, in the case of each instrument, over a period of twenty-nine weeks. In the course of the trials they are subjected to extremes of temperature of 35° and 95° Fahrenheit, and from the steadiness of the rate during the whole period, in connection with the greatest difference between one week and the next, including the change from cold to heat, the trial numbers are derived which determine the rank which the chronometer takes among a large number on trial.

All of the English makers whose chronometers were exhibited have at various times had their instruments included in the Greenwich trials, and all of them had succeeded in taking high rank in these trials. The fact that only first-class instruments are put into

these competitive trials attests the merit which belongs to a successful competition, and each of these exhibitors had at some time achieved that success.

When it was determined to test the adjustments of the marine chronometers by an actual trial at the Exhibition, the representatives of the English chronometer-makers whose chronometers were on exhibition were requested by the Judges to furnish some of their instruments for the trial. This resulted in a consultation by the persons interested, and the sending of a written communication to the Judges, in which it was stated that, as no previous intimation had been given that such trials would be made at the Exhibition, that since no such trials had been made at any previous International Exhibition, and that since they could not advisedly select the proper instruments from among those on exhibition, justice to the makers whose agents they were required them to decline to accede to the request. This communication was signed by the persons representing Charles Frodsham & Co., M. F. Dent, J. Sewill, Victor Kullberg, and Thomas Mercer. Accordingly the trials were commenced without including any English chronometers, but before the close, Mr. Gibson, representing James Poole & Co., of London, who had not signed the communication above mentioned, and who had not been consulted, as it seems, upon receiving notice that the trials were in progress, promptly sent to the Judges two of Poole's chronometers to be subjected to any trials desired.

M. F. DENT, *London.*

Several marine and surveying chronometers. The former were of the usual construction, and had different forms of auxiliary compensation for the balance. In two of them the auxiliary compensation was by means of auxiliary laminæ, with curb-screws to limit the action, constructed in the usual form. In the case of one chronometer the balance was of a new form, invented by Mr. Dent. There is a flat rim of brass and steel, the latter below. This carries a bar on which is placed the compensating weight, and this bar has the laminæ reversed, namely, brass below and steel above. The action of the balance-springs was found to be very symmetrical, and all the indications short of an actual trial were of workmanship of the first order. The surveying chronometers, intended for field and exploring expeditions, were smaller than the smallest size of marine chronometers, but much larger than the usual pocket chronometers. The balances had auxiliary compensation in the ordinary form. The balance-springs were of the form designated as "tria in uno," by which

it is to be understood that the spring is cylindrical, terminating above and below in flat spirals. The object of this form is to diminish as much as possible the errors of the action of the spring due to changes of position, and this is important in the case of an instrument which is to be transported in the pocket of the observer. Another essential was very ingeniously provided for. There was applied a novel and effective method of preventing overbanking.

CHARLES FRODSHAM & CO., *London.*

Several marine chronometers which were exquisitely finished, and which were doubtless good instruments, although, for the reasons already mentioned, not subjected to any trial for their adjustments. Most of those exhibited were of the ordinary construction. There was one which had an extra large roller for the escapement, and provision was made by which a double vibration might be made while unlocking only once. In connection with this exhibit was the collection of various forms of compensation balances already mentioned. There was a marine chronometer with an attachment for electric connection to control the vibrations of a magnet armature. There is a long and delicate spring placed with one end bearing against a platinum point. In the middle of this spring is a jewel tooth, which is acted upon by a wheel having sixty teeth and revolving once a minute. The spring is made very light and very long, so as not to produce any sensible effect upon the rate of the chronometer, whether it be used in the electric circuit or not. The application of a condenser, to prevent deflagration at the point of contact by the spark at the opening and closing of the circuit, would be a desirable addition to this instrument.

J. SEWILL, *Liverpool.*

Several marine chronometers. They were of the usual construction, with simple compensation, and their merit consists chiefly in the good quality of the work in connection with the very moderate prices charged. Sewill's chronometers have stood well in the Greenwich trials, but in these cases they were probably superior instruments to the cheaper ones exhibited at Philadelphia. All of their instruments, however, are sent to the Liverpool observatory to be rated and tested before they are sent out.

V. KULLBERG, *London.*

Two sizes of marine chronometers. The larger, eight-day chronometers, had the parts connected with the escapement attached

to a separate plate. The compensation had an auxiliary to modify the action in the extremes by means of a curb brought into action at the proper time. The smaller two-day chronometers were similarly constructed and were equally well finished. One of the chronometers exhibited had a flat rim balance, steel uppermost, similar to that in the Dent chronometer, already mentioned. The arrangement of the adjustment of the compensating weights, however, was better than in Dent's form. The balance-springs were hardened and tempered without blueing, for the avowed purpose of preventing the usual acceleration due to new springs. They were lacquered to prevent their rusting.

THOMAS MERCER, *London.*

A similar collection of chronometers, which were constructed in the usual manner. There were no novelties worthy of particular mention. The finish was good and the springing was apparently properly done, although no actual trials were made to determine the accuracy of the adjustments.

MESSRS. JAMES POOLE & CO., *London.*

These were the only English makers whose chronometers were subjected to any trial whatever. Two chronometers were taken from among those on exhibition, and were subjected to partial tests. From the statement already made of the circumstances of the case, it will be understood why these chronometers were not received by the reporter in time for a trial for the adjustment of the balance-spring. The finish of the parts of these chronometers was excellent, and the action of the balance-springs entirely symmetrical. This house is justly regarded as of the highest rank in England; and the reporter does not doubt that if the chronometers had been received in season for the trial of the isochronism of the balance-springs, they would have endured the requisite test as completely as they did that for temperature. So far as compared, the two on trial gave the following results:

Period.		Balance vibrating in	Average Temperature.	Daily Rate of No. 5699.	Daily Rate of No. 5700.
			°	s	s
1876.	July 29 to July 31 .	Long arcs	72	+3.07	−0.65
	" 31 to Aug. 2 .	Cold	38	+3.29	+1.76
	Aug. 2 " 4 .	Heat	88	+2.77	0.00

Chronometers provided with Poole's auxiliary compensation have generally ranked very high in the Greenwich trials.

FRENCH CHRONOMETERS.

There was but a single exhibitor of chronometers from France, although that country occupies a high rank in the manufacture of these instruments. Trials are regularly made at the *Dépôt des Cartes et Plans de la Marine*, at Paris, in some respects similar to those at Greenwich, and usually the productions of all the principal French makers are included in these trials. The chronometers are tried in heat, in cold, and in the ordinary temperature of use. Their rank is then determined by adding to the error in the ordinary temperature the greatest error in heat or cold.

A. H. RODANET, *Paris.*

Marine chronometers, constructed entirely in his own establishment. The arrangement of the parts was somewhat different from what is usual in the American and English chronometers. The escapement was exposed, and the motion of the balance-spring quite different from the usual motion of cylindrical springs, effected by means of a peculiar terminal curve. Mr. Rodanet's chronometers have shown very steady rates on long sea-voyages, and have taken high rank in the Paris trials. The balances have simple compensation. One of these chronometers was subjected to trial for the accuracy of its adjustments, and the following results were obtained:

Period.	Balance vibrating in	Average Temperature.	Daily Rate of No. 421.
		°	s
1876. July 26 to July 29	Short arcs	75	—9.64
" 29 " 31	Long arcs	72	+1.06
" 31 to Aug. 2	Cold	38	+2.01
Aug. 2 " 4	Heat	88	+1.00

It appears, therefore, that the temperature errors are small, but that the isochronal adjustment of the balance-spring requires further correction. It should be stated, however, that the mainspring was let down so far that the vibrations of the balance were very short, and hence the test was much more severe than would correspond with any fluctuations to which the motion of the balance would be subjected in actual use.

DUTCH CHRONOMETERS.

There were chronometers exhibited by two Dutch makers. The long career of this nation in extensive commerce on the seas would lead us to expect that of necessity their horologists would devote considerable attention to the construction of marine chronometers.

The two manufacturers whose productions were exhibited have secured an excellent reputation for their instruments.

A. HOHWÜ, *Amsterdam.*

His excellent astronomical clocks have already been noticed. He exhibited also marine chronometers constructed by himself. The balances had auxiliary compensation in the ordinary form, with auxiliary laminæ and curb-screws to control the action in the usual manner. Two of these chronometers were subjected to trial for the accuracy of their adjustments, with the following results:

Period.	Balance vibrating in	Average Temperature.	Daily Rate of No. 575.	Daily Rate of No. 596.
		°	s	s
1876. July 27 to July 29	Short arcs	75	—153.93	—16.18
" 29 " 31	Long arcs	72	—152.06	— 0.45
" 31 to Aug. 2	Cold	38	—215.14	— 1.26
Aug. 2 " 4	Heat	88	—155.90	+ 3.12

It is evident that No. 575 needed overhauling, and that it was not in proper condition for trial. The probability is that it had been injured in some way in transportation to Philadelphia. In the case of No. 596, the results go to show that the isochronal adjustments are yet imperfect. The springs were let down so much that the vibrations were very short, and hence the full effect of this error is exhibited. The temperature error is larger than ought to be expected, especially since the balance had auxiliary compensation.

A. DE CASSERES, *Amsterdam.*

Marine chronometers of the usual construction and with well-finished movements. One of them was subjected to trial, and the results were as follows:

Period.	Balance vibrating in	Average Temperature.	Daily Rate of No. 573.
		°	s
1876. July 27 to July 29	Short arcs	75	—10.17
" 29 " 31	Long arcs	72	— 8.49
" 31 to Aug. 2	Cold	38	—15.96
Aug. 2 " 4	Heat	88	— 8.06

The outstanding temperature error is considerable, but the difference between long and short arcs is so small, considering the extremely short arcs of vibration which were obtained in the trial, that the isochronal adjustment must be regarded as entirely satisfactory. The chronometer had not been properly rated, or else it had suffered some disturbance in transportation.

SWISS CHRONOMETERS.

The attention of the Swiss horologists is directed principally to the production of the best possible specimens of pocket-chronometers, and, consequently, they have not produced as many marine chronometers as might be expected, considering simply the magnitude of the horological industry in that country. However, the Swiss makers have, from time to time, produced some excellent marine chronometers, the finish and the adjustments being in complete accordance with their known skill as horologists.

H. GRANDJEAN & Co., *Locle.*

Several marine chronometers, showing excellent workmanship, and having certificates attesting their running qualities, as determined in the observatory at Neuchâtel. These instruments having been thus already subjected to trial in an astronomical observatory, no further trials were necessary. The results obtained at the observatory of Neuchâtel, and derived from a trial extending through eight weeks, were as follows:

No. of Chronometer.	Mean Daily Rate.	Mean Daily Variation.	Variation for 1° Centigrade.	Difference before and after Oven.	Difference between first and last Week.	Difference between the Extreme Rates.
	s	s	s	s	s	s
91 .	+1.15	±0.16	+0.09	+1.55	+2.06	2.96
92 .	+1.87	±0.18	+0.04	—0.48	—0.27	1.29
94 .	—0.81	±0.08	+0.04	—0.19	+0.57	0.94

Nos. 86, 87, and 90, which were exhibited by the same makers, gave also excellent results in the observatory trials. The trials were simply the running rate in the ordinary changes of temperature, with the exception of a single day, during which they were kept in heat. The results are therefore not sufficient to show how closely the isochronal adjustments were made, nor the inequalities of rate due to the irrationality of the compensation. Still, the daily record of No. 94, while under trial, was extraordinarily good, and there can be no question but that it is a superior instrument. In the trials of chronometers made at Philadelphia, two of the Grandjean chronometers were used, in connection with others, to carry the time forward from one night's observations with the transit instrument to another, and their performance was found to be entirely satisfactory.

SPANISH CHRONOMETERS.

D. JUAN HOMS, *Barcelona.*

A marine chronometer constructed by himself, with a device in connection with the escapement to secure a constant force in the com-

munication of the impulse to the balance. The instrument exhibited was so poorly constructed that it was impossible to form any estimate of the character of his alleged improvement.

V. POCKET CHRONOMETERS AND WATCHES.

It has already been remarked that the number of fine clocks exhibited was very small, the number and variety being confined chiefly to the clocks of commerce, known generally as house clocks. In the case of marine chronometers, the number exhibited was considerable, and the productions of those known to be the most successful manufacturers were well represented, although many makers of established reputation did not exhibit. While it is true also that several eminent manufacturers of pocket chronometers and watches did not send their productions to the Exhibition, yet the exhibits made represented in the most satisfactory manner the productions of every country in which the watch-making industry has any importance in respect to either the quantity or the quality of the productions. Not only was the number of exhibitors large, but the number of specimens of each grade of manufacture was also large. In one instance the number of specimens shown by a single exhibitor exceeded two thousand. We may therefore, by considering in detail the productions of the different countries, as shown in the International Exhibition, form a correct idea of the present state of this most important industry, and by comparison of results we may derive very definite information in regard to the progress which has been made in perfecting the movements of watches of every grade.

AMERICAN WATCHES.

AMERICAN WATCH COMPANY, *Waltham, Mass.*

This was the most extensive exhibit of watches shown; it consisted of about 2200 completed watch movements, the majority of which were provided with gold or silver cases. This represented the product of their factory for six working days. The extent of the exhibit, the conspicuous manner in which the watches were displayed, and the beauty of finish of the movements and the cases, all contributed to attract daily the attention of crowds of visitors. This was the first International Exhibition at which the products of our watch-manufactories were exhibited, and on account not only of the magnitude which the industry has assumed, but also on account of the excellence of the productions, it is proper to describe here the development of this branch of our manufactures.

Until the inauguration of this new enterprise in 1850, the watches and pocket chronometers used in the United States were imported from abroad, and principally from England and Switzerland. The prevalent notion had been that the production of these delicate machines could only be made with success in those countries where labor was cheap, and where the training and secrets transmitted from one generation of watch-makers to another made possible anything like perfection in the art. It is true that several of our artisans had shown great excellence in the finishing and adjustment of marine chronometers, so much so that it was well established that there was no lack of intelligent mechanics whose understanding of the principles of horological science, and of their application in practice, was beyond question; but when the requirement was a pocket time-keeper, even of inferior quality, the field of production looked uninviting from a commercial point of view. It was fortunate, perhaps, that the attempt finally made had been delayed so long, because an opportunity had been afforded to develop among our countrymen that ingenuity which has astonished the world in the production of machinery in a great degree automatic, or in the highest degree labor-saving in its operation. Not only this, but the fabrication by such machinery of the parts of other machines with such uniformity that the similar parts of these machines, made in any number whatever, become interchangeable, had arrived at a high degree of perfection. This system forms so important a part now of all our production of machines, for whatever purpose used, and is hence so well understood, that it is necessary barely to allude to the fact. Independently of the advantages which result from the mere perfection of the manufacture in the adjustment of the parts, essentials of the highest importance, the convenience of this system in facilitating repairs is its most important feature in an economic point of view. This, it is well understood, is all-important in the case of those machines in most general use, such, for example, as sewing-machines or agricultural machines. How much more important in the case of such delicate machines as watches, which have become the necessary companions of persons in every walk of life, and whose proper fabrication by the ordinary methods can only be undertaken by the most experienced workmen. The development of our watch-making industry has been a part of this scheme, and there can be no doubt from the results already achieved that this is its triumph.

Now that the results are before us, we can imagine the scheme faintly outlined, but still distinct and inviting, in the minds of our countrymen who first conceived the project to manufacture watches

by machinery, and thus by the application of forces other than human, to overcome the commercial difficulty resulting from the difference of wages here and abroad. These were Aaron L. Dennison and Edward Howard, of Boston, Massachusetts. The former was an expert watch-repairer, and the latter a skilled clock-maker. In 1848, Mr. Dennison suggested to Mr. Howard the project of attempting the manufacture of watches by machinery, and two years afterwards, in company with Samuel Curtis, also of Boston, they established at Roxbury, Massachusetts, a factory of this kind, and commenced the manufacture of watches which bore the name "Boston Watch Company." Subsequently they removed their establishment to Waltham, ten miles from Boston, and there, having organized as an incorporated company, they erected a small factory where now stands the imposing establishment of the present American Watch Company. At the expiration of three years the company became bankrupt, on account of unexpected obstacles encountered, and their property was purchased at an assignee's sale, by R. E. Robbins, of New York, for the firm of Appleton, Tracy, & Co. By an act of the Legislature of Massachusetts, a corporation was created, to be known as the "American Watch Company," with a capital of $200,000, which was soon advanced by subscriptions to $300,000. This company succeeded to the business already established, and has continued to develop it, until it now possesses by far the largest manufactory of the kind in the world. The capital has been increased by subscriptions from time to time until now it amounts to $1,500,000.

In the hands of managers who had a mastery of the commercial machinery, and operated by mechanics whose ingenuity and intelligent application of the principles of horological art and science made the work of a quality to merit success, this company, in an untried field, and against the opposition of prejudice and cheap foreign production, have fought their way to unparalleled success. The factory is located in a quiet suburban town, free from the dust and annoyances of the city, so that with extensive buildings, supplied with every appliance in the way of machines which it would seem that human ingenuity can devise, and surrounded by the neat cottages of the workmen, nature and art conspire to facilitate a work so delicate as the production of a watch such as modern demands require.

The factory consists of twenty-one departments, each under the proper foreman and his assistants. The whole is in charge of C. Vanderwoerd, as mechanical superintendent, whose skill as a mechanic is sufficiently attested by the machines for watch-making which attracted the attention of crowds of visitors in Machinery Hall during

the whole period of the Exhibition. For the sake of giving, as it were, an inside view of this establishment, it may not be amiss to particularize these departments. They are:

1. An extensive machine-shop, including draughting-room, where the various machines for watch-making are constructed, which therefore becomes the foundation of all.

2. The press-room, where the metals, brass, steel, copper, etc., are prepared for punching, and then punched into the blanks for wheels, regulators, ratchets, clicks, indexes, hands, dials, etc., the larger brass pieces, such as plates, bridges, and barrels, being punched for them from their own patterns at Waterbury, Connecticut, thus avoiding the freight on whole brass sheets and return chips to that great centre of brass-working for New England.

3. Frame-rooms, where the brass and nickel frames are made complete up to the process of stoning.

4. Dial-making and enameling.

5. Dial-painting.

6. Flat steel-work made and finished.

7. Jewel-making from the rough stone to the finished hole, using diamond and sapphire as the working materials, and ruby, chrysolite, garnet, and aqua-marine for the jewels.

8. Train-making, including barrels, wheels (except scape-wheels), barrel and pallet arbors, balance-staff, pinions, cannon-pinion.

9. Hardening and tempering of *all* steel pieces.

10. Train-finishing.

11. Screw-making.

12. Setting jewels in watches.

13. Hand-making.

14. Escapements, including fork, pallets, roller; scape-wheel, and putting them together.

15. Balance-making.

16. Springing, including hair-spring- and mainspring-making.

17. Gilding, including stoning and frosting.

18. Assembling the parts of the watches.

19. Adjusting the movements.

20. Engraving.

21. Silver case-making, in several divisions.

Supplementary to all these, there are all the needful smaller rooms such as for blacksmithing, piping, carpenter's shop, packing, etc. The motive-power is supplied by two engines of 25 and 35 horse-power, respectively, and the number of persons employed exceeds 800, half of either sex. There are many important operations in the

manufacture of watches by this method where the delicate manipulation of female hands is of the highest consequence, and it ought to be mentioned here that for this labor the amount of wages paid by the company is determined by the skill and experience required, not by the sex of the operatives.

It is not the purpose of this report to give a description of the details of the processes, and only such allusion to them will be made as may be necessary to make clear the matters under consideration. As regards the individual machines employed, in number the aggregate of the various kinds amounting to thousands, each of its kind performs some special work, either in forming or finishing pieces, and it performs those operations always in the same manner. Sometimes the functions of the machine are performed automatically, but generally the human operator is present to direct its movements; nevertheless the result is always to do its work, even if it be a very trifling performance, to thousands of pieces alike, so that the great desideratum of the production of interchangeable parts for movements of the same caliper is effected. While the system adopted affords practically a perfect interchangeability of the parts, yet it must be understood that the polishing and finishing of the parts leaves often microscopic differences which might be of importance in the case of fine movements. When therefore the parts of these watches are assembled, the exact sizes of the jewels are measured by means of the requisite gauges, the finest of which measures the seventeen-thousandth part of an inch. In this way systematic provision may be made for that freedom only in the operation of the parts of the movements which is essential to the proper performance of their functions under the conditions of temperature and other adventitious circumstances under which they are to operate.

Each watch of this character is numbered, and the exact sizes of all its pivots and jewels are accurately recorded. Hence, should any part of the watch fail, the factory can supply, upon receipt of the number of the movement, an exact duplicate of the required part.

The exhibit contained specimens of all the varieties of movements manufactured by this company. Of full plate movements there are seven distinct grades. These again are divided into varieties such as stem-winding and key-winding, or by varying the balance, making it in nickel, steel, gold, or bi-metallic of brass and steel for compensation, and also by varying the number of jewels. Of three-quarter plate movements there are four distinct grades, subdivided similarly into varieties. The total annual product of the factory is upwards of 100,000 watch movements and 50,000 silver watch-cases. The gold

cases required are made by Messrs. Robbins & Appleton, in New York. The principal market for this product is in the United States, but already a considerable demand for these watches has been created and is now being supplied in England, Germany, and Russia. The value of the annual product of these two establishments exceeds $2,000,000.

In the examination of the quality of the watches produced by the American Watch Company, it became necessary to consider first the mechanical contrivances by which the parts are executed, and then the manner in which these are brought together in the completed movement. While introducing so much that is novel in the way of machinery and processes of execution, there has been no attempt, in respect to the parts of the movements, at innovations which are not of recognized merit. There are certain well-established principles in reference to the proper construction of the train which have resulted from the application of the laws of mechanics, such as relate to the form of the teeth of the wheels, the leaves of the pinions, and the proper numbers for each. It is well established also, that for the purposes of a watch to be carried in the pocket, the lever escapement is to be preferred. The results of careful experiments show that when the lever escapement, the duplex escapement, and what is known as the chronometer escapement, are equally well constructed, and placed in movements with equally good trains and equally well sprung, the performance is substantially the same. There being, therefore, no objection to the lever escapement as regards the time-keeping properties, and there being good reasons for its adoption in preference to the two others named when the manner in which the watch is to be carried is considered, the propriety of this form of construction, even for the finest watches, is put beyond question. There is one innovation upon what was, in this country and in England, until recently regarded as an essential principle of watch construction, which the company ventured upon at the outset. This consisted in dispensing with the fusee and chain, and using in preference the going-barrel, thus reducing very much the size and the complexity of the watch. The Swiss manufacturers long ago ventured, so to speak, to adopt to a considerable extent this form of construction, but the poor quality of the watches which the careless greed of manufacturers and importers flooded upon the markets of the world did much to strengthen the idea, among the dealers as well as among the purchasers, that a good watch must be provided with a fusee and chain, so that the ultimate force with which the power of the mainspring acted upon the escapement should be as nearly constant as possible. Hence the

popularity of the English lever watches in this country, and hence the tenacity with which in England they still adhere to the notion that no reliance can be placed upon any other form of construction.

But wisely the pioneers in the introduction of this industry into our country decided to adopt the going-barrel, so as not only to reduce the size and expense of the watch, but also to obviate the great expenses for repairs made necessary by the frequent breaking of the chain. And besides, in the case of the breaking of the mainspring, the recoiling of the barrel, from the sudden removal of the pressure, creates the risk of injury to the teeth of the great wheel and to other important parts of the movement. Yet, in spite of these discouragements, the necessity of a fusee and chain seemed so apparent to those not versed in the knowledge of the action of the balance-spring as regulating the movement of the watch, that this notion, so well fortified, did much to oppose the introduction of the watches in which these parts were wanting. Certain it is that many scientific skeptics upon this point had to be convinced by actual trials before yielding their assent to the possibility of the construction of an accurate time-keeper upon the simpler system. It is indeed true that the force of the mainspring is not constant, but if the difference be not too great, the isochronal property of the hair-spring in proper or even approximate adjustment is quite sufficient to regulate the movement of the watch within the limits required. If the mainspring be of considerable length, and the number of turns when wound such that only comparatively a few turns are unwound during twenty-four hours, there will be very little variation of the force actually trans mitted to the train, so that if the watch is wound regularly the small differences which would result are counteracted so completely by even an approximate isochronal adjustment of the balance-spring as to become practically insensible.

The safety of these simpler movements from any injury which might result from the breaking of the mainspring is most effectually provided for in all the watches made by this company by a device known as "Fogg's Patent Safety Pinion," invented in 1865. The arbor is tapped with a triple left-hand thread upon which the pinion screws. This pinion is toothed into the great wheel upon the barrel, and the action of the wheel upon it is in the direction of the tightening of the screw. Whenever, therefore, the mainspring breaks, the recoil of the great wheel unscrews the safety pinion from the arbor, and thus instantaneously releases the whole movement from the effect of the reaction.

It is well known that the teeth of the wheels should be epicycloidal

in form, and the attempt is always made, in a properly-constructed movement, to secure this form in the final process of finishing. Often, however, in the manufacture under the old system, partly on account of the difficulty of securing the proper form, and partly on account of the peculiar æsthetic notions of workmen who conceived a dislike to epicycloïdal teeth because they had in mind the resemblance of their form to that of the bishops' mitres, this important principle was disregarded. Another obstacle arises from the difficulty of producing in miniature with precision what it is possible to draw only upon a magnified scale. But by the application of the machines constructed for this purpose, not only in this instance, but in many other similar cases in the production of the various parts, is the difficulty obviated, and the requirements of theory rendered possible in practice. The forms of the cutters and polishers of the machines which cut the gearing are kept true by means of a machine which gives the true epicycloidal form, so that by proper attention to the depthing when the train of wheel-work is put together in the watch movement, the perfection of smooth and continuous action is secured. It is right here that the superiority of the American system comes into important operation. While it is possible by the ordinary methods, by patient work, to produce the wheels and pinions with the requisite degree of perfection, yet manifestly, on account of the necessary expense, this cannot be done in the case of the common grades. But by the method under consideration the action of the machines is precisely the same for all grades. There may be degrees of finish, but the form is unchanged, and the cheapest movements have this excellence in common with the best. The difference of the cost of watches not specially adjusted will therefore depend upon differences in the number of jewels, the finish of particular parts, and the character of the balance.

The excellence of the train being beyond question, the next and the important consideration is the character of the work in the construction of the parts connected with the escapement. These are all constructed by processes quite similar to those already mentioned, and hence attention may be directed particularly to the hair-spring and the balance. It is well known that it is upon the proper performance of these parts that the accurate time-keeping property of the movement depends. Any imperfection here will make manifest in a striking degree any imperfections in the train, and even when everything else is perfect, a failure here renders the movement practically worthless for the purpose for which it was intended. The balance-spring must be of the very best material, must be evenly

coiled, and must be so tempered as to secure a maximum degree of elasticity, and a continuance of this quality undiminished. There will then be a relation between its elastic force, the length to be brought into action, and the weight of the balance which it is to control, to be determined so as to make the vibrations of this balance isochronous whether they be long or short. An examination of the process employed in springing the movements showed that this is accomplished by means of instrumental appliances with all the precision necessary, even in the case of the commonest grades of movements. For higher grades, not including those specially adjusted, to be considered hereafter, the process gives results of wonderful accuracy. The symmetry of the action of the spring, as its coils are caused successively to contract or expand, is carefully tested by an indicator constructed for that purpose, and the condition that the centre of torsion shall be coincident with the axis of the balance-staff is thus secured in advance. The elastic force of the spring for different degrees of winding is next determined, and thereupon it is possible to select a balance from an assortment of compensated balances, prepared so as to fulfill the requirements for poise and compensation by identical processes, such that the conditions for isochronism are very approximately realized without any special adjustments after actual trials of the running movement. In this way movements which are of low price, and adapted to the general market, are produced which perform often equal to the most carefully adjusted. An actual trial, by timing tests of movements of this grade, has shown generally only small errors in the several adjustments for temperature, isochronism, and position, and in some instances they have been within the limits attainable by special attention to these adjustments in the usual way. Thus often, for a very moderate price indeed, may be obtained a movement of a very high order of excellence, such that if it had been adjusted by the usual method, on account of the attention required from the adjuster, its cost would have been necessarily increased tenfold.

The results of the examination of all the grades so far considered were, as stated in the report for an award, that for watches not specially adjusted, and including all the ordinary and medium grades as to price, this company is enabled to produce, in the case of such movements, better watches than are produced by the other methods in use, and that these products are worthy of special commendation.

This company also exhibited watches, the parts of which were also made by machinery and highly finished, and which had been specially adjusted for isochronism, for position of the balance, and for tem-

perature. One of these, selected at random, was taken down, and all its parts minutely examined. The workmanship throughout was found to be excellent, and the materials the very best. The plates were of nickel, the wheels of gold. The holes were jeweled and capped, and the springs of excellent quality; and the balance-spring of the form known as the Breguet spring. The workmanship being of a quality to warrant a movement of the highest order, it remained to determine by actual trial the accuracy of the adjustments, and the regularity of the motions from day to day. The limited time available, in the course of the examinations, for a work of this kind, made it difficult to give to these trials proper attention; but the requisite astronomical instruments being in position and available near the United States Government Building (being there as a part of the National exhibit), ten of these movements were taken from among those on exhibition, and subjected to trials. The first trials for errors of position were made for seven of these movements by Mr. Theodore Gribi, a member of the Swiss Commission, whose services as mechanical expert were of great value to the writer of this report in the course of the examinations in the department of horology. The trials made by Mr. Gribi were during days when the ranges of temperature were considerable, the average temperature in the building during the middle of the day often exceeding 100° Fahrenheit. The results of Mr. Gribi's comparisons during a period of ten days, as computed by him, are as shown by the following table:

No. of Watch.	Variation Between				Sum of the Four Variations.
	Dial Up and Dial Down.	Pendant Up and Pend't Down.	Hanging and Lying.	Pendant Up and Pendant to Right.	
	s	s	s	s	s
670,087........	2.36	8.35	0.11	3.77	14.59
670,061........	1.40	1.50	2.65	3.23	8.78
670,082........	0.73	0.98	0.30	0.01	2.02
670,083........	1.76	0.44	7.01	5.01	14.22
670,092........	0.88	7.31	3.18	5.19	16.56
670,044........	3.74	1.45	0.28	0.46	5.93
Mean..........	1.81	3.34	2.25	2.94	10.34

The numbers given show the difference of rate corresponding to a period of 24 hours.

The movement numbered 670,052, which was also compared by Mr. Gribi, is, for reasons which will subsequently appear, omitted from this table.

Subsequently, during the trial of the marine chronometers, these movements were subjected to further trials to determine their errors, and especially the errors of compensation for temperature. The results derived by the reporter from his observations in connection also with the comparisons made by Mr. Gribi, were communicated to the Centennial Commission in explanation of the award recommended by the Judges for the production by this company of first-class pocket chronometers. These results are as shown by the following table:

No. of Watch.	Variation for $\pm 1^\circ$ of Temperature.	Difference Between Long and Short Arcs of Vibration.	Maximum Error of Position.
	s		
670,075	$\mp$0.034		
670,099	$\mp$0.188		
670,095	$\pm$0.024	s	s
670,061	$\mp$0.014	2.5	1.4
670,087	$\mp$0.038	0.4	8.3
670,083	$\pm$0.012	2.2	0.5
670,052	$\pm$0.064	1.3	6.7
670,044	$\mp$0.052	0.6	1.4
670,082	$\mp$0.064	0.1	0.8
670,092	$\pm$0.240	0.4	7.0
The mean of all gives	$\pm$0.07	1.07	3.7

These numbers refer to the variations of the rate corresponding to a period of 24 hours.

In the reduction of the observations for the movement numbered 670,052, included in the above table, it was assumed that an abnormal error, shown by Mr. Gribi's comparisons, was due to an error of observation, but subsequently it was found that the movement was not in proper running order, on account of clogging pieces of lint adhering to the escapement, and that it needed overhauling; and hence in the subsequent trials another movement was taken.

The results thus obtained were sufficient to show that the claim of the production of first-class pocket chronometers was well founded, and they served as the basis for the award to the company for that class of movements. Although sufficient to warrant the award made, it is true that they do not depend upon a series of observations sufficiently extended to be compared fully with the results for the trial of first-class pocket chronometers at the Swiss observatories where such trials are regularly made. And, besides, in the temperature trials there was some uncertainty as to the position in which the watches had been placed in the refrigerator during a portion of the 48 hours

that they were kept in the cold. In order, then, to put the movements to a severer test, they were taken to the observatory at Ann Arbor, and there subjected by the reporter to a rigorous trial. The whole period of this final trial was eleven weeks, which is five weeks longer than the first-class pocket chronometers are tested at the Swiss observatories. The trial began on September 9, and ended on November 26, 1876, and the results for the successive weeks are shown by the table on page 100.

In these tables the watches are arranged in the order of their merit, as indicated by the range and fluctuations of the rate in all the changes of temperature from the beginning to the end of the trial; not taking into the account the errors arising from the change from the horizontal to the vertical position.

During the seventh week the watches were placed in different positions, with the dial up, in respect to the magnetic meridian, but no sensible errors which might be attributed to the action of magnetic forces were indicated.

In the ninth week of the trials the watches were kept during two days at a mean temperature of 36.7°, and then transferred to a warm room, in which they were kept for two days at a mean temperature of 95.1°.

During the tenth week, the watches were kept three days with the dials down, in order to find the difference of rate between the dial up and the dial down.

By a comparison of the rates from day to day during the periods in which the position remained unchanged, the mean daily variation of the rate of each chronometer was obtained, and the variation of the rate, assumed to be uniform through a considerable range of temperature, corresponding to a variation of one degree of the thermometer, was derived by a comparison of the rates at the extremes of temperature to which they were subjected. In order to exhibit more fully the character of these movements the tables on pages 101 and 102 are subjoined, the numbers in which have been derived from the data obtained in the course of the final trials now under consideration.

Those who are familiar with investigations of this character will understand, without further explanation, what the numbers in these tables indicate; but for the purpose of making the results clear to the general reader, it is necessary to consider them more fully, commencing with that on page 101.

The mean daily rate, as shown in the second column, is the average rate by which each watch gained or lost on mean solar time during the whole period of the trials, and the next column shows the average

TABLE

Showing the Performance of the Watches during a Trial of Eleven Weeks.

WEEK OF TRIAL.	First.	Second.	Third.	Fourth.	Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Eleventh.
Range of Temperature............	57° to 69°	60° to 72°	47° to 69°	43° to 53°	35° to 50°	39° to 66°	40° to 61°	49° to 65°	31° to 99°	40° to 77°	55° to 69°
Mean Temperature................	62.1°	66.5°	53.1°	48.7°	43.4°	54.8°	48.8°	56.3°	61.8°	52.7°	61.4°
Position................................	Horizontal. Dial up.	Horizontal. Dial up.	Vertical. Pendant up.	Vertical. Pend. down.	Vertical. Pend. right.	Vertical. Pend. left.	Horizontal. Dial up.	Horizontal. Dial up.	Horizontal. Dial up.	Horizontal. Dial up&d'n	Horizontal. Dial up.
NUMBER OF THE CHRONOMETER.	WEEKLY SUMS OF RATES.										
	s	s	s	s	s	s	s	s	s	s	s
670,044........................	− 5.65	− 4.80	+ 27.55	+ 52.10	+ 42.05	+ 18.20	+ 2.05	− 3.50	+ 1.40	+ 11.35	− 5.55
670,089........................	+ 3.05	+ 3.35	+ 47.40	+ 70.60	+ 114.85	+ 66.85	+ 11.90	+ 13.50	+ 12.65	+ 6.40	+ 10.05
670,082........................	− 13.65	− 7.60	+ 9.10	+ 15.85	+ 9.65	− 10.25	− 7.90	− 11.30	− 11.30	− 16.75	− 21.95
670,095........................	− 20.85	− 16.95	− 18.15	+ 7.85	+ 1.40	+ 25.75	− 20.90	− 16.50	− 8.55	− 18.90	− 20.00
670,087........................	− 14.15	− 17.20	+ 6.35	+ 79.20	+ 67.40	− 1.95	− 8.45	− 14.35	− 3.55	− 9.50	− 18.85
670,083........................	+ 1.70	+ 7.80	+ 5.15	+ 57.60	+ 71.95	+ 42.45	+ 19.05	+ 27.95	+ 23.40	+ 10.20	+ 18.20
670,090........................	+ 7.45	+ 6.45	+ 36.55	+ 27.30	+ 42.50	− 1.75	+ 24.90	+ 17.80	+ 29.45	+ 34.00	+ 29.80
670,061	− 27.70	− 39.50	+ 1.25	− 20.95	− 45.80	− 32.50	− 47.60	− 49.40	− 35.70	− 36.05	− 55.45
670,099........................	− 20.25	− 26.15	+ 20.20	+ 66.15	+ 69.85	+ 53.25	− 6.25	− 18.05	− 10.50	− 0.35	− 22.65
670,092........................	− 15.90	− 11.35	− 59.43	− 31.62	− 63.05	− 62.15	− 32 45	− 31.55	− 9.30	− 22.35	− 7.20

These watches are all stem-winders. The duration of the trial in each position was such as to indicate unmistakably the total effect of irregularities of motion due to the change of position, and through considerable changes of temperature.

TABLE

Showing the Mean Daily Rate and the Mean Daily Variation of the Rate, corresponding to a Period of Twenty-four Hours, in Different Positions, etc.

NUMBER OF THE CHRONOMETER.	Mean Daily Rate.	Mean Temperature.	Mean Daily Variation.	Mean Variation for $\pm 1^{\circ}$.	Before and after Oven.	Difference between Hanging and Lying.	Difference Hanging and Pendant Left.	Difference Hanging and Pendant Right.	Difference Dial Up and Dial Down.	Sum of these Four Variations.
	s	°	s	s	s	s	s	s	s	s
670,090	+ 2.76	59.5	± 0.12	∓ 0.098	0.0	− 2.98	− 5.30	− 0.11	− 1.30	9.69
670,089	+ 1.15	"	0.14	∓ 0.038	0.5	− 5.75	+ 2.71	+ 9.25	− 1.77	19.48
670,082	− 1.75	"	0.20	∓ 0.041	0.0	− 1.83	− 2.69	− 0.31	− 1.55	6.38
670,095	− 2.47	"	0.21	∓ 0.014	0.7	+ 0.26	+ 6.23	+ 2.53	+ 0.10	9.12
670,083	+ 2.34	"	0.26	∓ 0.089	0.5	+ 1.27	+ 5.48	+ 8.67	− 3.25	18.67
670,044	− 0.38	"	± 0.27	∓ 0.094	0.2	− 3.28	− 1.16	+ 1.10	+ 3.85	9.39
670,092	− 2.57	"	0.30	± 0.214	0.7	+ 3.91	− 0.74	+ 1.52	− 1.25	7.42
670,087	− 1.82	"	0.31	∓ 0.005	0.1	− 2.69	− 1.13	+ 8.23	− 0.20	12.25
670,099	− 2.47	"	0.39	∓ 0.164	0.3	− 4.34	+ 5.01	+ 5.44	− 0.37	15.16
670,061	− 6.08	"	0.54	∓ 0.014	0.4	− 4.63	− 4.75	− 6.87	+ 0.45	16.70
Mean of all	± 2.38	59.5	± 0.27	± 0.077	0.3	± 3.09	± 3.52	± 4.40	± 1.41	12.42

In this table the watches are arranged in the order of their mean daily variations of rate.

In trials of this character, one of the conditions of competition often imposed in advance is that the difference between hanging and lying shall not exceed a certain limit, and the result has been an attempt to accomplish this at the sacrifice of the adjustments in other positions. The movements under consideration were not adjusted specially in reference to any such condition.

TABLE

Showing the Mean Daily Rate in Different Weeks, and the Variations of Rate for Changes of Position.

Difference Pendant Right and Left.	Difference of Rate between First and Eleventh Weeks.	Difference before and after Vertical Positions.	Mean Daily Rate for Weeks in which Position was Horizontal. For Temperature 60° Fahr. Before Exposure to Heat. First.	Second.	Seventh.	Eighth.	After Exposure to Heat. Ninth.	Tenth.	Eleventh.
s	s	s	s	s	s	s	s	s	s
−5.18	+3.19	+0.87	+1.26	+1.56	+2.44	+2.17	+4.39	+4.68	+4.44
−6.40	+1.00	+0.51	+0.50	+0.74	+1.25	+1.78	+1.74	+1.38	+1.49
−2.38	−1.19	−0.74	−1.87	−0.83	−1.58	−1.77	−1.54	−2.02	−3.07
+3.64	+0.12	−0.81	−2.95	−2.33	−3.13	−2.31	−1.20	−2.85	−2.84
−3.19	+2.36	+0.01	+0.44	+1.69	+1.71	+3.66	+3.50	+2.35	+2.72
−2.27	+0.01	−0.61	−0.63	−0.12	−0.72	−0.83	+0.37	−0.71	−0.66
−2.30	+1.24	+0.53	−2.73	−3.04	−2.48	−3.69	−1.74	−1.23	−1.33
−9.33	−0.67	−0.18	−1.85	−1.92	−2.10	−2.35	−0.37	−1.93	−2.58
−0.43	−0.34	−0.06	−2.54	−2.67	−2.74	−3.21	−1.22	−1.45	−2.99
+2.09	−3.96	−1.40	−3.93	−5 55	−6.96	−7.11	−5.08	−5.45	−7.90
±3.72	±1.41	±0.57	±1.87	±2.04	±2.51	±2.89	±2.12	±2.40	±3.00

In this table the watches are arranged in the order of their mean daily variation of rate.
The means given at the bottom show the average accuracy of the performance of the whole group.

temperature during the same period. The fourth column exhibits the mean variation of the rate from day to day, excluding the differences which resulted from the changes of position. The amount of this mean daily variation for a particular chronometer is a fair index of the perfection of its manufacture, except so far as relates to the special adjustments next to be considered.

In reference to the numbers given in the fifth column for the variation of the daily rate corresponding to a variation of one degree in the mean temperature, it should be stated that they represent this coefficient as derived from the differences corresponding to a range of temperature from 36.7° to 95.1° Fahrenheit, disregarding the effect due to the irrationality of the compensation, for which, in marine chronometers, a secondary or auxiliary compensation is frequently applied to the balance. In reducing the rates to a mean temperature, when such reductions were required, a small correction was introduced on this account, whenever its amount was clearly indicated by the observations.

The numbers given in the column headed "before and after the oven," exhibit the change of the daily rate found by comparing the rates on the days preceding and following the placing of the watches in a heated room, and show how far they are affected by sudden and violent changes of temperature.

In order to understand the significance of the numbers in the succeeding columns, which relate to the differences due to changes of position, it is necessary to call attention again to the character of the final adjustments of a first-class pocket chronometer. The general nature of these adjustments, and the methods by which they are approximated to by this company in the case of even the cheaper grades of movements, have already been alluded to, but for our present purpose further consideration of this subject will not be out of place.

The parts of the escapement being supposed to be of proper construction and in proper adjustment in the movement, the attention will finally be directed to the balance and to its controlling spring. In reference to the balance, it is often erroneously supposed that the office of the compensation by means of a bi-metallic segmental rim of brass and steel is to counteract simply the effect of the expansion of the balance itself by an increase of temperature, whereas in fact the change of rate arising from the loss of the elastic force of the balance-spring, by an increase of temperature, is five times greater than that resulting from the expansion of the balance. And still further, there is a change of rate due to the elongation of the spring from the same cause. The

compensation of the balance must provide for all these changes, and they amount to a change of the rate to the extent of more than one minute in twenty-four hours for a change of only ten degrees in the temperature. This, however, is now so well understood, that within limits which are always possible to good workmanship the compensation can be readily effected, and the poise of the balance with reference to the axis of its staff successfully arranged. But when the attention is finally directed to the adjustment of the balance-spring, the difficulties to be encountered require the highest knowledge and the most skillful manipulation on the part of the adjuster. On account of the change in the amount of the friction in different positions, and on account also of different degrees of viscosity of the oil at different times, and on account, further, of inequalities of motion communicated by the train, the arcs through which the balance will vibrate will be subject to considerable fluctuations even under the most favorable circumstances. When we add to these the interferences which are constantly operating as the watch is carried about in the pocket of the wearer, it becomes of the highest importance that the isochronism of the spring shall be as perfect as possible. The property of an isochronal adjustment, it is well known, is that the vibrations of the balance shall be performed in the same time whether they be long or short. This will require, in general, for a balance of a given weight and diameter, a certain determinate length of the spring in action, and a form such that this action shall be symmetrical in reference to the motion of the balance each way from the point of quiescence. When this adjustment is once secured, it is evident that any change of the acting length of the spring will destroy this important provision; and here comes in one of the difficulties in the adjustment of a pocket chronometer which is to be carried in different positions. In the case of a marine chronometer, there is provision made that the instrument shall perform its functions always in the same position, and hence, when the balance is once poised, regulated to time, and the isochronal adjustment of the balance-spring completed by comparing the times of vibration, or the daily rate, in long and short arcs, obtained by varying the acting power of the mainspring, the desired result is accomplished. But in the case of a watch, even if the poise be perfect, the isochronal adjustment made perfect for a horizontal position will be found to be in error in other positions, because of the modification of the action of the spring as its position is changed. It becomes a very difficult matter, therefore, to secure the perfection of the adjustments for a variety of positions when an extreme limit of precision is sought. It has already been mentioned how these adjustments are by instru-

mental appliances effected in all the watches made by this company, when once the required relation of the parts has been established; but the production of movements of the highest degree of excellence requires that further and special adjustments be made.

The elastic force of the spring as its coils are contracted or expanded from the state of quiescence, must change its value in a ratio depending upon the weight and diameter of the balance, for the case of isochronal action, and this relation is found by careful trials. The weight of the balance is not affected by the temperature, but its diameter is thus changed, and here again a source of error creeps in. It is the accumulation of all these errors, infinitesimal almost in each vibration, which, in the course of the twenty-four hours, gives a finite error in excess or defect, and thus alters the rate of the watch. If the acting part of the spring be too short, the tension as it is wound will be too great, and in the course of long arcs of vibration the rate will gain, while in short arcs it will lose. But if the acting part be too long, the tension due to the elastic force will be too small, and the watch will lose during the long arcs of vibration and gain in the case of the short arcs. Any bend in the spring changes the effective length in action, and hence the final isochronal adjustments are effected by modifying the terminal curves of the spring without unpinning it from the collet or the stud.

It is evident, further, that when once these adjustments are effected, it is of the greatest consequence that the conditions remain unchanged. Hence the importance of a spring properly and permanently tempered. It has been established by experiment that the effect of the process of tempering the spring is to leave it, before it has been put into use, in a condition such that the relations of its molecules do not become permanent until it has been for some time in continuous vibratory motion, and further, that the effect of such motion is to produce in the outset an increase of its strength and elasticity, and hence an acceleration of the rate of the movement which it controls.

The use of the flat spring in these chronometers requires that, for the best and most permanent adjustment, a terminal curve for the spring be brought out of and over the plane of its coil. This is not essential for a spring whose action shall be always in the same position, but when the positions are to be different the form of this terminal curve performs an important office in the adjustment. Sometimes both ends of the spring are turned into such terminal curves, and theoretically there would seem to be good reason for this arrangement; but the difficulties of finding, in practice, the proper forms for two such terminal curves is a sufficient warrant for confining the attention

to a single curve, as in the Breguet form of the spring adopted in the construction of the watches under consideration.

The accuracy of the adjustments depending upon the positions in which the watches were placed is sufficiently indicated in the several columns of the tables. A reference to the table showing the weekly sums of the rates will indicate the time allotted in the trials to each position in which the movements were tried. It will be observed that the periods were such as to make prominent the irregularities depending upon these changes of position, and further, that the trials extended to six positions, besides tests for the influence of possible magnetic action. It is hardly necessary to add that the tables establish conclusively the excellence of all the adjustments. And it should be borne in mind, in a just determination of the merits of these movements, that they were subjected to great vicissitudes before they received the long trial of eleven weeks. They had been taken from the factory to the Exhibition before its commencement. They were not regularly wound and kept running, but only so kept during the progress of three distinct trials separated by considerable intervals, and they were exposed to great changes of temperature. After the partial trials at Philadelphia they were allowed to remain unwound and at rest, then they were again wound and started, carried to Ann Arbor, and, after an allowance of only three days to assume their regular rate, the final trials began. These extended over the long period of eleven weeks, and through considerable ranges of climatic temperature, circumstances such as to test severely their running qualities. In order to do full justice to the exhibit, it would have been better to extend the trials to a much larger number of movements, because in the case of so small a number involved in the means taken, a single watch going badly, or not very closely adjusted for errors of temperature and position, affects the mean results much more than if the number were greater. The limitation of the number was not the fault of the exhibitors, but was determined by the convenience of the reporter, who could not undertake, in connection with the other duties devolving upon him, the trial of a greater number.

It would be of benefit to the company if their finest productions could be subjected to trial every year in some astronomical observatory. Nothing has done more to stimulate the Swiss manufacture towards excellent workmanship and the most careful adjustments possible than the competitive trials which have been made for a series of years at the observatories at Neuchâtel and Geneva. In this way, by comparison of results, can some idea be formed of the progress made and the degree of perfection attained. The trials of the first-

class pocket chronometers at the Swiss observatories extend over a period of six weeks. They are tried in five positions and in the oven. The second grade of pocket chronometers are subjected to trial for four weeks, in two positions, hanging and lying, and in the oven. It will be seen by reference to the parts of this report which refer to the English, Swiss, and German exhibits, that the labors of the Judges were very much facilitated by the certificates issued from the observatories, showing the results of the actual trials of the adjusted movements which were on exhibition. And in a determination of the progress which has been made in America, there was thus provided a standard of acknowledged excellence. It is not the purpose of this report to make direct comparisons of the productions of different manufacturers. The reader who is curious in such matters will find, in most cases, the requisite data under the heads of the report relating to the exhibits in question. But in order to convey to the general reader an idea of what the system of manufacture under consideration has made possible in a newly-developed industry in this country, it is proper to state here that the reporter has compared the results of the trials as heretofore given with those furnished for all the first-class fully-adjusted watches in the International Exhibition, and that it is clear beyond question that the chronometers numbered 670,044, 670,082, and 670,095 are altogether superior to any others exhibited. The tables already given show clearly the excellence of their adjustments, and the smallness of the mean daily variation of their rates. The best of these, taking everything into account, is No. 670,044, for which the mean daily rate was only thirty-eight one-hundredths of a second, and for which the difference of mean daily rate between the first and eleventh weeks of the trial was only one-hundredth of a second. The steadiness of the rates of these watches is best shown by placing in juxtaposition the average daily rate during several weeks separated by considerable intervals, and during which the determining conditions were very different, as already stated. The following are the results:

Week ending	Mean Daily Rate of No. 670,044.	No. 670,095.	No. 670,082.
	s	s	s
1876. July 20........	—0.50	—3.60	—2.80
Sept. 18........	—0.63	—2.95	—1.87
Oct. 30........	—0.72	—3.13	—1.77
Nov. 26........	—0.66	—2.84	—3.07

These numbers, for the sake of comparison, are reduced as nearly as possible to the temperature 60° Fahrenheit.

The performance of No. 670,044 is extraordinary, considering the vicissitudes to which it was subjected and the long period of nineteen weeks during which its rate is considered. The mean daily variation of the rate is greater than that of each of the other two, but this may be due to the imperfect elimination of the error of the eccentricity of the second's dial in the daily comparisons. Its temperature correction is also apparently somewhat larger, but that all the essentials for good performance were present is best attested by the steadiness of the rate from week to week as it was under trial.

No. 670,089 is hardly of inferior rank to the three here specially mentioned, although the sum of its position errors is greater than the general average.

The results thus developed show clearly enough that there is no lack, in this country, of mechanics skilled in the most abstruse principles of horology, and able to execute their work in accordance therewith. But it is a lamentable fact that the great majority of those who are to care for these productions after they are put into use are in total ignorance of the fundamental principles upon which the performance of a watch depends. It would be of inestimable benefit to the public, from an economic point of view, if there could be established in this country schools of horology, where young men desiring to become experts in the repairing even of watches could be enabled to acquire that knowledge and experience which is essential to the proper performance of this kind of work. In every industrial or intellectual pursuit in life it is desirable that men should be thoroughly educated in the principles underlying their profession, and in none more so than in that which we are considering. It is true that we find occasionally men in this profession also imbued with the desire to know the why and the wherefore, who have sought to acquire, and often have acquired, such education; but too often indeed do we find men professing to be accomplished watch-repairers who are in profound ignorance of the principles upon which the peculiar functions of these instruments are correctly performed, and who are liable to undo in a moment what has been achieved by the patience and skill of an accomplished manufacturer. The reader will already have in mind, from what has been under special consideration, that the greatest care is necessary in respect to fully-adjusted watches. For needed repairs they should be intrusted to men who fully understand that the relations of the balance and the hair-spring should

never be disturbed, even to the minutest bending or lengthening of the spring, or disturbance of the weights of the balance.

It is apparent, therefore, how important it is to the possessor of a good watch that it shall not be liable to be ruined by the ignorant manipulation of some professed watch-repairer who undertakes to clean it. The desire to regulate such a watch to run in conformity with a worthless clock, with pretended compensation of the pendulum, has often been the source of mischief to the machine which should regulate instead of being regulated. And further, it should be borne in mind that the use of watches has now become so general that the expenses of cleaning and repairs must amount to millions of dollars annually. These expenditures result partly from necessity, partly from the worthlessness of movements palmed off by irresponsible dealers upon a confiding public, and partly from the ignorance of those who undertake the repairs. It is one of the merits of the system of watch-manufacture under consideration, that it reduces to a minimum the expenses to be incurred and the dangers to be encountered.

The general reader, unacquainted with the results which are obtained from clocks and chronometers of the best construction by those who are concerned with the accurate determination of time, may perhaps expect closer results than those indicated in the foregoing tables, especially when recalling to mind some of the extravagant statements often made as to the running qualities of watches in the hands of wearers whose comparisons have been made at long intervals, and often with uncertain standards, thus obtaining accidental coincidences. The trial of the movement from day to day, with exact standards of comparison, will necessarily reveal those errors which are compensated or concealed when the intervals of comparison are very long.

The fullness of this report on this particular exhibit has been made necessary on account of the disposition manifested by certain foreign manufacturers to arrogate to themselves and their country the sole possession of that knowledge and skill which can render possible the higher achievements of horological art. While conceding, as they have been compelled to do, by the inexorable logic of the facts before them and the world, the superiority of the American system of manufacture in the case of all but the specially-adjusted watches, they have been disposed to cling to the latter as of their exclusive control, and to look with suspicion upon any results which go to show the possibility of excellent production in these higher grades also. The final adjustment of a watch for position, fo[illegible]m, and for tem-

perature, requires only that the maker shall be able to produce the best quality of springs, of the desired form, and to make a balance of proper proportions, it being supposed that the escapement and the train have been properly constructed. The adjuster must understand the methods of springing, must know how to secure the poise of the balance, and how to modify the acting part of the spring so as to secure isochronal action in different positions and at different temperatures. It cannot be supposed that the science and skill which have achieved wonders in all of what might be called the inferior operations should find an insurmountable barrier here. The results of the trials of the very few watches selected for that purpose from among those of the exhibit under consideration, show that such is not the case. And the manufacturers may claim superiority for their finest productions, for the very simple reason that the machine to be adjusted finally for all the errors which interfere with accurate time-keeping is a better machine when constructed upon their system than when constructed upon the old system, and the better machine being equally well adjusted with the inferior one, in respect to these isochronal functions, must, in the nature of things, be of a perfection more enduring, and must satisfy better all the conditions for the highest productions of horological art.

Elgin National Watch Company, *Elgin, Ill.*

A collection of movements representing the different grades of their manufacture, but, for reasons which were not stated, these were not entered for competition for an award. The methods of construction adopted by this company are, in many respects, analogous to those employed by the American Watch Company, and already described. This Western company, in fact, had its origin in the emigration to the West of a considerable number of the skilled employees of the Waltham Company, and so far as not protected by patents, the methods in use at Waltham were put into operation at Elgin. The Elgin company was organized in 1864, and at once commenced the manufacture of the necessary machinery for the production of watches upon the American system. In 1867 the first watches were made and put into the trade, and from that time forward this company has been engaged in an extensive manufacture, ranking next to the American Watch Company in the amount of its annual productions. The factory, which gives employment to about seven hundred persons, is located at Elgin, Illinois, about forty miles west of Chicago. It is supplied with every equipment necessary for its work. All the va-

rieties of movements required by the trade are constructed by this company, with the exception of fully-adjusted movements, which have only been made in particular instances, and not for sale to the trade. It is understood to be the intention of the managers of this company to commence the manufacture of the highest grade of movements also. At present they manufacture five distinct grades of full-plate movements, and three grades of three-quarter plate movements. These are subdivided into varieties in the usual manner, according to the number and quality of the jewels, the form of the balance, or the mode of winding. The best movements are adjusted for temperature and approximately for position. The parts of each grade are made interchangeable to the limit regarded as practical and economical. For protection of the movements against injury resulting from the breaking of the mainspring, they are provided with a safety-pinion, not so good under all circumstances as Fogg's, but still sufficient for the purposes intended. The pinion is clamped to the arbor of the centre wheel by means of a nut screwed upon the same arbor, which is promptly unscrewed by the force of the reaction in case the mainspring breaks, thus unclamping the pinion and leaving it free. All the movements which are full-jeweled are adjusted for temperature by trial.

Since the movements exhibited by this company were not in competition for an award, they were not subjected by the Judges to any critical tests as to their running qualities as instruments of precision. The reporter has, however, at various times subjected watches made by this company to trials for steadiness of rate, and the results have been satisfactory. In one instance one of their best movements, which had been carefully adjusted, but which had the ordinary flat, spiral balance-spring, was used upon an eclipse expedition to Sicily, in 1870, in preference to a first-class pocket chronometer by Frodsham, for the service for which a pocket chronometer was needed, for the reason that it was found to maintain a steadier rate, when carried about, than the chronometer mentioned.

EMPIRE CITY WATCH COMPANY, *Jersey City, N. J.*

A collection of watch movements and parts of movements, constructed at their factory. There was no person in attendance to give any information in reference to this factory, and the movements on exhibition appeared to be indifferently executed, and by no means creditable to the present state of the watch-making industry in the United States.

JULIUS ELSON, *Boston, Mass.*

A new form of watch-regulator patented by him. It acts in the nature of a compound lever, and will undoubtedly answer well for the purpose of its construction.

HIETEL BROTHERS, *Philadelphia, Pa.*

An improvement in the fork of a lever-escapement, converting it into a spring-bar in such a manner as to prevent the breaking of the roller-pin, or its excessive rebounding when the balance has received a violent shock.

ENGLISH WATCHES.

The conservatism of most of the English watch-makers, in resisting the innovations and improvements of later times, has resulted in a steady decline of the watch-making industry in Great Britain, and especially for export to other countries. The old-fashioned, clumsy English lever watches, with fusee and chain, are still made and sold in considerable quantities for home demand, but they have long since ceased to be sent abroad as in olden times. It must not be supposed, however, that the best manufacturers do not continue to produce the finest specimens of their art. Nearly all of the manufacturers of marine chronometers devote attention also to pocket chronometers. The latter are often constructed with the same care as their marine chronometers, and are fully adjusted for the errors of temperature and position. In respect to these there has been no decadence of the industry, but it has been in reference to the common grades of movements intended for the purposes of commerce. Numerous specimens of the better class of English movements were shown at the Exhibition.

M. F. DENT, *London.*

In addition to the marine chronometers already mentioned, Mr. Dent exhibited pocket chronometers; repeating watches, and stop or timing watches, of ordinary size, and of excellent workmanship throughout. The balance-springs were in some cases the flat spiral, with a single terminal curve above. In others, they were provided with cylindrical springs, terminating in a flat spiral below, or, in some instances, in two flat spirals, one above and the other below. The former is known as the "duo in uno," and the latter the "tria in uno," balance-spring. The use of these forms of balance-springs is believed by the makers to facilitate the adjustments for isochronism and position, and doubtless such is the case; but whether the performance is

any better than in the case of a flat spiral, with the proper terminal curves, when once the proper adjustments are effected, remains to be determined by an extended series of trials, and the reporter has no knowledge of any such having been made.

CHARLES FRODSHAM & CO., *London.*

An exhibit, in connection with their clocks and marine chronometers, of pocket chronometers of varied forms, all finely executed. The springing, in particular, appeared to be excellently done, so far as could be determined without an actual trial, for which the movements were not submitted. There were also repeaters, of which the repeating mechanism had been made in Switzerland, and the movement adapted to it at their establishment in London. One of the pocket chronometers had a "duo in uno" balance-spring, which had been designed by the late Charles Frodsham as long ago as 1852.

NICOLE, NEILSON, & CO., *London.*

A collection of pocket chronometers, and sporting, calendar, and repeating watches, manufactured by them. Their watches showed signs of good workmanship, and the number and variety of the specimens exhibited were such as to indicate that in respect to complicated watches they are rivals of the most extensive manufacturers of these in Switzerland. In most cases the English makers import the parts of the mechanism of the complicated movements from Switzerland, and simply adapt the English time-movement to them; but the reporter was assured that Messrs. Nicole, Nielson, & Co. manufacture every part. Their arrangement for stem-winding is simple and effective. There is no arbor running into the case, but attached to the stem is a wheel working into a conical pinion, which gears into another wheel acting upon the barrel. The conical wheel is held by a bridge, which also fixes the movement in the case, so that by taking off the bridge the movement is at once released from the case. They exhibited also calendar watches, of various styles, and all apparently well executed. In some of the complicated watches a dial was provided on the front and on the back, which arrangement appears to be especially convenient in the case of some kinds of complicated watches.

J. SEWILL, *Liverpool.*

A display, in connection with his marine chronometers, of several fine watches, which were stated to have been adjusted for the errors of temperature and position, although no results of trials were shown.

There were also several complicated watches, as well as a collection of the ordinary English lever watches.

VICTOR KULLBERG, *London.*

Pocket chronometers, made with the same care as his marine chronometers. These had shorter detent springs than usual, and so placed as to be in a vertical position when the watch is hanging. His stem-winders can only be wound when opened, and there is an indicator to show when the spring is wound up.

JAMES POOLE & CO., *London.*

The marine chronometers of this firm were the only ones submitted for actual trial by English makers. They also exhibited several well-finished watch movements. They were not subjected to any timing tests, but so far as could be otherwise determined, they appeared to be well sprung. Generally they had flat spiral balance-springs, with a single terminal coil above. One had a cylindrical spring, and had been carefully adjusted for temperature and isochronism. The workmanship was quite in accordance with what might be expected after an examination of the excellent marine chronometers constructed by him.

FRENCH WATCHES.

The manufacture of watches has been an important industry in France since the earliest production of these instruments, and the history of watch-making in that country is, indeed, so closely related to that in Switzerland, that it would be difficult to draw a dividing line. In many cases, a century ago, the most famous makers in Paris had a great part of the work actually done in Switzerland, and the same is true to-day. At Besançon, however, there is an extensive manufacture of watches, and the result has been a corresponding diminution of the imports of Swiss watches and parts of watches into France. The French watches shown at the Exhibition were ostensibly by Paris makers, but an examination showed that they were in most cases of Swiss manufacture. The houses which exhibited were: B. HAAS, JR., & CO., *Paris;* BRÉGUET & CO., *Paris;* and J. B. GONDY & CO., *Pontarlier.* The watches were noticeable chiefly on account of the elegant decoration of the cases. There were simple and also complicated movements, but of ordinary quality, without any novelties requiring special mention. The name of Bréguet is justly celebrated in the history of horology, but, in the present instance, it is

used in connection with movements actually made in Switzerland to enhance their value in the eyes of purchasers.

Watch-springs of excellent quality were exhibited by HANGARD, *of Paris*, and EUGÈNE MOAT, *of Revigny*.

GERMAN WATCHES.

Watch-making in Germany has never reached that extent of manufacture which it has in some other countries; nevertheless, excellent movements have come from German workshops. Of late the quantity of the productions has considerably increased. Some excellent specimens of German manufacture were shown at the Exhibition.

MESSRS. A. LANGE & SONS, *Glashütte, Saxony*, have established a reputation for the production of good pocket chronometers, and several specimens of their best work were on exhibition. There was also shown a working model of the lever-escapement which they employ. The acting surfaces of the pallets are curved so as to secure uniformity of action during the communication of the impulse. The finish of the parts was good, and the movements were well sprung. They were provided with trial-certificates, made at the Leipsic Observatory, under the direction of Professor Bruhns. The trials extended over four weeks, and the results are as shown by the following:

WEEK OF TRIAL.	No. 10,732.			No. 10,733.		
	Position.	Temperature, Centigrade.	Mean Daily Rate.	Position.	Temperature, Centigrade.	Mean Daily Rate.
			s			s
First........	Lying.	+ 23°	− 0.48	Lying.	+ 23°	+ 2.18
Second.....	Carried and lying.	+ 32° to + 18°	+ 1.68	Hanging.	+ 24° to + 18°	− 3.94
Third........	Hanging.	+ 18°	− 1.05	Carried and lying	+ 32° to + 18°	− 1.56
Fourth......	Lying.	+ 20°	− 0.90	Lying.	+ 20°	+ 1.43

WEEK OF TRIAL.	No. 10,926.			No. 10,927.		
	Position.	Temperature, Centigrade.	Mean Daily Rate.	Position.	Temperature, Centigrade.	Mean Daily Rate.
			s			s
First........	Lying.	+ 17°	− 0.63	Carried and lying.	+ 30° to 12°	− 0.10
Second.....	Hanging.	+ 18°	+ 1.76	Lying.	+ 18°	+ 0.15
Third	Carried and lying.	+ 30° to + 12°	− 2.30	Hanging.	+ 18°	− 1.61
Fourth.....	Lying.	+ 15°	− 0.12	Carried and lying.	+ 30° to + 12°	− 0.50

The observations were not sufficiently extended to show the error of compensation for temperature, nor to show very satisfactorily the

mean daily variation of the rate. During the weeks when the positions indicated are "carried and lying," the watches were carried in the pocket of the observer during the day, and during the night they were placed horizontal, dial up.

The VEREINIGTE UHRMACHER, *Glashütte, Saxony*, is an association of watch-makers, the members of which work singly in the production of particular parts, but bring together their several productions for the market. They furnish movements and parts of movements, and a collection of specimens of their work, of various grades, was shown at the Exhibition. The execution of the several parts appeared to be good, and while not showing any special merit, was yet sufficient to indicate that the association has, among its members, excellent workmen.

SWISS WATCHES.

The Swiss have been famous as watch-makers for nearly two centuries, and some of the most remarkable specimens of watch-work have come from that country. The system developed has been that of the minutest division of labor; individuals and families devoting their attention to the production of particular parts. It is said that a Swiss complicated watch, in general, passes through the hands of one hundred and thirty different workmen before it is put upon the market. The system of work by families scattered about in the country, as well as in the cities and villages, reduced the cost to a minimum in a country where wages were low. Besides, the minute division of labor made the acquisition of many parts of the trade comparatively easy, so that the result has been a rapid increase of the number of workmen, and too often a corresponding deterioration of the quality of their productions,—particularly so in reference to the lower grades of watches. For the finer specimens of work the production has been confined to a limited number of skilled artists, so that, in times past, it might have been said that while Switzerland supplied the poorest watches she also supplied the best.

The number of persons actually engaged in the watch-making industry in that country is estimated at 40,000, representing a population of 150,000 persons. The total number of watches produced annually has been enormous, sometimes reaching 1,600,000 completed movements, and the market has been found in almost every country of the globe. Besides the completed movements they have supplied watch-makers of other countries with parts of movements. The United States have furnished customers in abundance for watches of every grade, from the poorest to the best. The importations of these watches were approximately as shown by the following:

Year.	Number.	Year.	Number.
1864	169,000	1870	330,000
1865	226,000	1871	342,000
1866	262,000	1872	366,000
1867	207,000	1873	204,000
1868	209,000	1874	187,000
1869	206,000	1875	134,000

Among these importations were quantities of the very poorest specimens of Swiss production, and the sale of these by unscrupulous dealers has reacted seriously to the injury of their whole trade. In many parts of the country, on account of the impostures thus perpetrated, the very name of a Swiss watch began to be indicative of its worthless character. Proceedings of this kind undoubtedly aided in the introduction of the products of home manufacture, and the excellence of the common grades of American watches in comparison with Swiss watches of corresponding prices, being well known, did much to strengthen the confidence of purchasers of watches of a higher grade; and thus was stimulated and rewarded the production in the United States of fine watches as well as cheaper ones.

The rapid diminution of late in the number of watches annually imported from Switzerland into the United States is shown by the foregoing tabular statement, and the diminution there shown has continued in undiminished ratio. This falling off in the demand had seriously disturbed the business in Switzerland, but it was attributed to the general depression of business, and it was not until the International Exhibition at Philadelphia that it came forcibly to the knowledge of the Swiss manufacturers that the competition of the American factories was the real cause of their misfortunes. It has already been shown in this report that the application of the American system of labor-saving machinery to the manufacture of watches has overcome the commercial difficulty arising from the difference of wages in the two countries, while the production of interchangeable parts, and the uniformity and accuracy of their production, have established the character of the watches as accurate time-keepers, so that the lost trade can never be regained. The exportations to the United States having been for many years nearly, if not quite, one-quarter of the entire Swiss production, the crisis produced by the new rival in manufacture has been and continues to be a very serious one. The only solution which has been proposed as capable of furnishing a favorable result has been the introduction of the American system of manufacture into that country, where there are already so many skilled horologists and mechanicians. But the further difficulty to be encountered will be that which results from the conservatism of the people in opposi-

tion to all innovations. Capital is not wanting, and the skill of the artisans is unquestioned; but the sense of freedom inwoven by the system in vogue for centuries will make it difficult, if not impossible, to introduce the American system, according to which, while there is a minute division of labor, the whole work is done in a single establishment. Besides, too, in respect to the cheapness of production, the disparity of wages does not enter as so important a factor when the system of production by machinery is in competition in each case. While it is true that the application of labor-saving machines has been extensively introduced into watch manufacturing in Switzerland, yet it must be understood that these are of a very different character from those already mentioned in connection with the American system of manufacture.

The achievements in horology, and especially in the adjustment of watches as real instruments of precision, which have established the peculiar skill of the Swiss, have been due largely to the fostering care of the Government, which has provided astronomical observatories for the principal object of testing the adjustments of the best watches produced, and which, for many years, has stimulated the manufacturers to a generous rivalry by the establishment, in connection with the observatory trials, of competitive awards of prizes. These prizes have been sought, not for their intrinsic value, but rather for the distinction which they conferred. In addition to these trials, schools of horology have been established and fostered, where not only the requisite mechanical operations were taught, but where the knowledge of geometry, trigonometry, descriptive geometry, and drawing, and the general principles of mechanism fundamentally necessary to the higher branches of horology, could be imparted at the same time. That all these have resulted in bettering the quality of the work produced in that country is clearly shown by a comparison of the results of the competitive or other trials of the watch-movements from year to year.

Pocket chronometers of the first class are subjected to trial for six weeks, in five positions and in the oven, namely: first week, horizontal position, in the oven one day; second week, horizontal position; third and fourth weeks, hanging. Then, in the fifth week, two days pendant left, two days pendant right, and two days dial down. Finally, the sixth week, dial up. The second grade are tried four weeks, and only in two positions, horizontal and hanging, and one day in the oven. The third grade are subjected to trial for fifteen days, to find the steadiness of the daily rate and the degree of compensation for temperature. The trials are made chiefly at the obser-

vatories of Neuchâtel and Geneva, and the annual reports made by the directors of these establishments upon the results obtained show a steady approach towards greater perfection. The report of Dr. Hirsch, director of the observatory at Neuchâtel, for 1875, gives some very interesting statistics in regard to the results produced by different forms of escapements and balance-springs, as well as in regard to the progress made during several years in perfecting the several adjustments.

The mean daily variation of the rate of chronometers having different forms of escapements were found to be as follows in the years named:

YEAR.	FORM OF ESCAPEMENT.				MEAN VARIATION OF THE YEAR.
	Anchor.	Bascule.	Spring Detent.	Tourbillon.	
	s	s	s	s	s
1862	1.51	1.80	1.02	2.30	1.61
1863	1.39	1.28	1.37	0.64	1.28
1864	1.14	1.47	1.17	0.66	1.27
1865	0.89	1.01	0.70	0.42	0.88
1866	0.67	0.73	1.01	0.35	0.74
1867	0.70	0.61	0.74	0.52	0.66
1868	0.57	0.56	0.66	0.29	0.57
1869	0.61	0.58	0.60	0.55	0.60
1870	0.53	0.62	0.52	0.40	0.54
1871	0.56	0.53	0.47	0.56	0.55
1872	0.53	0.46	0.54	0.58	0.52
1873	0.62	0.63	0.56	0.72	0.62
1874	0.54	0.52	0.48	0.60	0.53
1875	0.46	0.47	0.17	0.49	0.46
	s	s	s	s	s
Mean variation during 14 years	0.601	0.745	0.706	0.706	0.652
Number of chronometers	1048	462	137	57	1704

The substantial agreement of the results for the different escapements is indicated by the numbers given in this table, so that for the purposes of a watch to be carried about in the pocket of the wearer preference should be given to the lever-escapement.

The differences of the results for different forms of balance-springs were also very slight in the case of the mean derived from a large number of fully-adjusted movements. The spherical hair-spring gave the least difference between the rates hanging and lying, although the actual difference was very little in its favor. The most uniform results were obtained with a flat spiral having a single terminal curve.

The progress made in the adjustments for steadiness of the daily rate, for position and for temperature, derived from the trial, each year, of a considerable number of movements, is shown by the following:

Year.	Mean Variation of Daily Rate.	Difference between Hanging and Lying.	Mean Variation for 1° Centigrade.
	s	s	s
1864	1.27	8.21	0.48
1865	0.88	6.18	0.35
1866	0.74	3.56	0.36
1867	0.66	3.57	0.16
1868	0.57	2.44	0.15
1869	0.60	2.43	0.14
1870	0.54	2.37	0.14
1871	0.55	1.90	0.13
1872	0.52	1.99	0.15
1873	0.62	2.59	0.15
1874	0.53	2.27	0.15
1875	0.46	1.97	0.13

In considering the numbers which express the mean daily variation of the rate on account of a change of one degree in the temperature, the reader will bear in mind that ten degrees of the centigrade scale are equivalent to eighteen degrees Fahrenheit.

L. Frankfeld & Co., *Geneva.*

Their watch movements have the escapement on a small plate separate from the train, so that it may be detached and replaced with ease. They exhibited stop-watches with two independent second-hands, and also the same with two independent minute-hands for intervals in excess of one minute. There were three stop-pushes, and notwithstanding the complexity there was a large balance and escapement, about the same as would be placed in a watch of the same size with simple movement. The movements were apparently well sprung, and the action of the stop-work was found to be prompt. The movements had been adjusted for temperature and for position, but in one case only was the observatory certificate exhibited, and this showed that the final adjustments for that movement had been properly made.

J. M. Badollet & Co., *Geneva.*

A collection of watches noticeable for the general good workmanship in the construction of the movements and in the decoration of the cases. Their watches have the usual adjustments, for those of their grade, for errors of temperature and position. In the collec-

tion were calendar and repeating watches, and a little watch whose diameter was only four lines.

HENRY GRANDJEAN & Co., *Locle.*

His marine chronometers have already been mentioned. He exhibited also pocket chronometers which were of a quality quite in accordance with that of these marine chronometers. One of them, No. 29,260, had a new mechanism for winding which appeared to be safe and effective. Another, No. 3412, a repeater, was constructed upon a new system, claimed to be more simple than the usual construction, beside having the great advantage of greater compactness. No. 29,708 is a calendar watch and chronograph. It has two distinct sets of hands separately adjustable, and the calendar is complete except for the intercalary day in leap-year. For a complicated movement this is an excellent production, and the makers are entitled to the highest credit for skill in their profession. Beside pocket chronometers of the higher grades, there were exhibited by the same makers watches of medium price, which were in all respects well made.

The results of the trials of the fully-adjusted movements, shown in this exhibit, as furnished by the Observatory of Neuchâtel, are as follows:

					Difference between					
						Hanging and				
Number.	Mean Daily Rate.	Mean Daily Variation.	Variation for 1° Centigrade.	Before and after Oven.	Lying and Hanging.	Pendant Left.	Pendant Right.	Dial Up and Down.	First and Last Weeks.	Extreme Rates.
	s	s	s	s	s	s	s	s	s	s
34,060	+6.26	±0.45	−0.22	+0.8	+2.46	−3.96	−0.06	−2.51	+3.07	9.0

This watch has bascule escapement and flat-spiral balance-spring, with double Phillips's terminal curves.

BRÉTING FRÈRES, *Locle.*

This firm exhibited two pocket chronometers having anchor escapements and flat spiral balance-springs with double terminal curves, Phillips's form. The finish of the parts was good, and the character of the adjustments is shown by the following results of the trial by Dr. Hirsch:

					Difference between					
						Hanging and				
Number.	Mean Daily Rate.	Mean Daily Variation.	Variation for 1° Centigrade.	Before and after Oven.	Lying and Hanging.	Pendant Left.	Pendant Right.	Dial Up and Down.	First and Last Weeks.	Extreme Rates.
	s	s	s	s	s	s	s	s	s	s
47,811	−2.12	±0.29	+0.01	+0.5	+1.14	−0.68	+1.02	−0.76	+0.72	3.2
47,812	−2.28	0.31	−0.17	+0.4	−1.01	+2.24	+0.74	+0.12	−0.37	3.4

H. R. Ekegrén, *Geneva.*

This maker is well known for the excellent performance of his adjusted watches. One of his movements was taken down and all its parts minutely examined. Throughout were evidences of the exact workmanship so necessary to the perfect action of the train and the escapement, and the accuracy of the adjustments is shown by the results of the trials at the observatory at Geneva, by Professor Plantamour, before the watches were sent to Philadelphia. The results of the trials were as follows:

Number.	Mean Daily Variation.	Mean Error of Position.	Mean Variation for 1° Centigrade.
	s	s	s
16,522 . .	±0.49	±1.10	±0.02
16,518 . .	0.89	2.24	0.29
16,519 . .	0.34	1.42	0.24
16,588 . .	0.76	1.42	0.11
16,779 . .	0.48	0.90	0.16
(Second trial). . .	0.30	1.47	0.18
16,766 . .	0.53	2.02	0.09
16,710 . .	0.49	1.62	0.14
16,726 . .	0.37	0.93	0.32
16,753 . .	0.41	2.61	0.28
16,691 . .	0.80	0.79	0.03
16,642 . .	0.51	1.32	0.27
16,903 . .	0.65	1.38	0.01

H. L. Matile, *Locle.*

Pocket chronometers with simple or complicated movements. No. 10,697 is a double chronograph, with calendar and moon's phases and minute repeater. The complicated mechanism is well finished and compactly arranged. No. 10,661 is also a minute chronograph. It has a simple mechanism to secure the operation of the movable minute-hand.

The trials of the movements on exhibition at the Observatory of Neuchâtel gave the following results:

					Difference between					
						Hanging and				
Number.	Mean Daily Rate.	Mean Daily Variation.	Variation for 1° Centigrade.	Before and after Oven.	Lying and Hanging.	Pendant Left.	Pendant Right.	Dial Up and Down.	First and Last Weeks.	Extreme Rates.
	s	s	s	s	s	s	s	s	s	s
10,045	+2.58	±0.51	—0.01	—1.6	+2.64	+1.82	+0.62	—1.19	+1.09	5.7
10,661	+4.09	0.86	—0.18	+0.1	+4.87	Chronometer of second class.				11.6
10,697	—3.84	0.70	—0.31	—0.5	—0.52	"		"		7.9
10,571	—2.55	1.18	+0.18	+0.5	+1.48	"		"		7.8

In connection with this exhibit were shown also some specimens of the work of Mr. Charles Meylan, inventor of a new form of minute

chronograph. One was a minute chronograph, and also a minute repeater, both in one combination, of compact and elegant construction. Mr. Meylan is a resident of New York, but the complicated watches upon his plan are constructed by Mr. Matile, in Switzerland.

PATEK, PHILIPPE, & Co., *Geneva.*

Watches of various grades. The makers employ a variety of labor-saving machines in their construction. To a limited extent they construct parts which are interchangeable for the same grades of movements. Besides the watches of ordinary grades, this house has long had an excellent reputation for skill in the manufacture of fully-adjusted movements, and for the artistic decoration of the cases of their watches.

The fully-adjusted watches which they exhibited had been subjected to trial at the Observatory of Geneva, and the following are the results shown by the certificates furnished by Professor Plantamour:

Number.	Mean Daily Variation.	Mean Error of Position.	Mean Variation for 1° Centigrade.
	s	s	s
42,948	±0.45	± 1.23	±0.03
46,201	0.49	1.63	0.21
49,264	0.66	1.79	0.10
49,265	0.64	1.21	0.09
42,962	0.42	1.48	0.11
44,035	0.54	2.66	0.13
47,776	0.39	2.09	0.11
47,417	0.49	1.60	0.07
41,659	0.72	+ 2.20	—0.01
34,038	0.58	+ 1.55	+ 0.12
		Difference between Hanging and Lying.	
49,027	±0.38	+ 5.89	—0.33
49,111	0.61	—2.40	+ 0.64
49,062	0.55	+ 1.82	+ 0.26

TIFFANY & Co., *New York, N. Y.*

A collection of movements quite similar to these, constructed at a factory formerly belonging to them in Geneva, but now merged into that of Messrs. Patek, Philippe, & Co.

MESSRS. JACOT FRÈRES, *Locle,*

exhibited a collection of complicated watches. The minute repeaters had a novel arrangement of the striking parts, and there was also a pointer on the dial to show the winding, the mechanism for which is ingenious, simple, and efficacious. The watches had been tried at

the Observatory of Neuchâtel, and the following were the results obtained:

Number.	Mean Daily Rate.	Mean Daily Variation.	Variation for 1° Centigrade.	Before and after Oven.	Difference between Lying and Hanging.	Difference between Extreme Rates.
	s	s	s	s	s	s
199,313 . .	−1.40	±0.33	+0.01	−0.8	+2.74	4.6
199,315 . .	−4.78	0.42	+0.44	+1.5	−3.59	14.7
199,311 . .	−2.47	0.45	−0.05	+1.9	+3.34	6.6
199,307 . .	+1.03	0.45	+0.28	+1.2	−0.94	8.4
199,309 . .	+0.88	0.53	+0.37	+0.4	−0.88	9.9
199,310 . .	−4.12	0.67	+0.19	+4.5	−3.40	10.6
199,308 . .	−2.37	0.80	+0.19	+0.2	−0.17	6.1
199,314 . .	+1.35	0.80	+0.21	−0.9	+2.52	9.2
199,312 . .	+5.43	1.38	−0.07	0.0	+4.96	10.7

These watches had anchor escapements and flat-spiral balance-springs, with single Phillips's terminal curves. With a single exception, they were complicated movements.

LOUIS AUDEMARS, *Brassus.*

This maker is reputed to be one of the most accomplished manufacturers of watches in Switzerland. His exhibit consisted of a collection of simple and complicated watches. Some of the pocket chronometers had fusees and cylindrical balance-springs, and the whole workmanship was apparently of the highest order. These watches were reported to be fully adjusted, but they had not yet been subjected to any timing test at an observatory, and they were not submitted for trial at Philadelphia. One of the repeaters was a clock-striking, minute repeater, striking the hours and quarters like a clock, and repeating the hours, quarters, and minutes at will. Another minute repeater had also perpetual calendar and phases of the moon, the complicated construction of which was exceedingly compact. There was also a little ten-line minute repeater, with stem-winding, flat-spiral balance-spring, with Phillips's terminal curves, adjusted for temperature and position.

A. HUGENIN & SONS, *Locle.*

A collection of simple and complicated watches, and escapements for fine clocks. One of the watches had a tourbillon escapement. Their movements are constructed upon an excellent model, and, so far as could be seen, the workmanship was in all respects good. Two of the chronometers had been tried at the Observatory of Neuchâtel. One of them was a perpetual-calendar watch, with phases of

the moon, anchor escapement, and double Phillips's terminal curves. Its performance under trial is shown by the following:

Number.	Mean Daily Rate.	Mean Daily Variation.	Variation for 1° Centigrade.	Before and after Oven.	Lying and Hanging.	Difference between Hanging and Pendant Left.	Difference between Hanging and Pendant Right.	Difference between Dial Up and Down.	Difference between First and Last Weeks.	Extreme Rates.
	s	s	s	s	s	s	s	s	s	s
15,633	—1.79	±0.82	—0.29	0.0	—2.80	—4.01	+2.34	—4.49	—3.45	9.4
15,001	+5.69	0.57	Pocket chronometer of the third class.							3.6

The second of these is a double chronograph, with independent seconds and quarter-second hand.

Borel & Courvoisier, *Neuchâtel.*

Pocket chronometers, and watch-movements made of uniform size for each grade. The complicated movements exhibited by them had the ordinary arrangement of the mechanism, but they were exceedingly well constructed. One of their pocket chronometers, No. 54,025, shown at the Exhibition, had received a prize at the competitive trial at Neuchâtel in 1875, and the following are the results of the trials of this and others shown in their exhibit:

Number.	Mean Daily Rate.	Mean Daily Variation.	Variation for 1° Centigrade.	Before and after Oven.	Lying and Hanging.	Difference between Hanging and Pendant Left.	Difference between Hanging and Pendant Right.	Difference between Dial Up and Down.	Difference between First and Last Weeks.	Extreme Rates.
	s	s	s	s	s	s	s	s	s	s
54,045	+2.49	±0.69	—0.21	—0.7	—4.44	—2.67	+0.03	—2.41	—3.69	9.8
54,059	+1.59	0.20	—0.02	+0.7	+0.19	+1.82	+2.47	+0.15	+2.22	4.0
54,023	+0.86	0.26	—0.03	+4.3	+0.95	+2.50	+2.60	—0.37	+4.52	6.3
60,008	+0.27	0.21	—0.14	—0.3	+0.23	Not observed.		Class II.		6.0
54,025	+2.21	0.16	+0.08	+0.8	+1.16	"		"		2.9

These chronometers have anchor escapements and flat-spiral balance-springs, with single Phillips's terminal curves.

Charles Martin & Co., *Geneva.*

A collection of watches of their manufacture worthy of mention, on account of the quality of the workmanship shown in the movements, and on account also of the artistic decoration of the cases.

James Nardin, *Locle.*

Mr. Nardin is reputed one of the best manufacturers of watches in Switzerland. He exhibited a collection of pocket chronometers of his own manufacture made specially for the International Exhibition. They had not been subjected to trial at an observatory, and were not

submitted for trial at Philadelphia. Among them were repeaters, chronographs, and calendar watches. Besides the adjusted watches, there were movements of ordinary commercial grades.

CARL TAGLIEB, *Zurich.*

A watch in a large finger-ring, which was ingeniously arranged. Turning the watch movement in one direction in the ring winds up the spring, and in the other direction it sets the hands. There is a detent which clamps it when the hands are set.

DÉSIRÉ COLLIOT, *St. Imier.*

Cheap watches in silver or silver-plated cases, also a complete movement of four-line size, and a watch in a ring also about four-line size. It winds as a stem-winder. The hands are adjusted from a little door in the side.

R. S. RIGTRUP, *Locle.*

A new mechanism for watches without fusee. It is an ingenious and efficacious arrangement by which, in a watch without a fusee, a hand on the dial shows whether it is wound up or not, as well as the number of hours elapsed since the winding.

DANIEL DUCOMMUN, *Gorgier.*

A collection of watch movements for which the particular merit claimed is the neatness and strength of the model. The form is similar to that of the Jurgensen watches.

ERNEST FRANCILLON & CO., *St. Imier.*

Watches in the manufacture of which labor-saving machines are used, and for which many of the parts are interchangeable. The movements exhibited were all of cheap grades.

J. B. BITTERLIN-SCHMIDT, *Locle.*

Specimens of finished jewels for watches and precious stones for watch-cases, which showed excellent workmanship.

EUGÉNE BESANCET-BLANC, *Travers.*

A collection of finished watch jewels and specimens of setting of jewels. In this exhibit was shown a ruby pinion, and also a ruby cylinder for a cylinder escapement, and ruby rollers for chronometer escapements. The workmanship exhibited in this collection was of the highest order, and worthy of special commendation.

Watches of ordinary commercial grades were exhibited by G. HONEGGER, of *Bienne;* GABRIEL DIDISHEIM, of *St. Imier;* AEBI & LANDRY, of *Madretsch;* ALLIANCE HORLOGÈRE, of *Chaux-de-Fonds;* FAVRE FRÈRES, of *Neuveville;* D. PERRET FILS, of *Neuchâtel;* A. & E. CHATELAIN & WOELFLIN, of *Geneva;* MAURICE STAHL, of *Chaux-de-Fonds;* and ERNEST HUMBERT, of *Locle.*

AMI RAUSS, *Geneva.*

Fifty specimens of dial-work, some of which required microscopic aid in the examination.

J. CORCELLE & CO., *Geneva.*

A large collection of dials, constructed for manufacturers of watches for various countries, the painting of which was in excellent taste and microscopically exact.

DUFAUX, LUTZ, & FILS, *Geneva.*

A collection of balance-springs, cylindrical, globular, and flat spiral, in both blue and white, of ordinary quality.

BAEHNI FRÈRES, *Bienne.*

A large collection of balance-springs, and also wire for springs, to be commended for the excellent quality and the variety of their manufacture.

C. MONTANDON GENTIL-LUTZ, *Servette.*

Flat-spiral and cylindrical balance-springs for watches, which bore admirably tests for evenness of gauge, elasticity, hardness, etc.

AIMÉ PERRENOUD, *Geneva.*

A collection of steel and gold balance-springs, in form flat, globular, or cylindrical, the qualities of which are great elasticity and toughness, evenness of gauge, and correctness of winding.

Main-springs for watches, of good quality, were exhibited by E. KLEIN, of *Geneva;* CHARLES JEANJAQUET, of *Neuchâtel;* EDWARD BERLIE, of *Geneva;* and AUBERT FRÈRES, of *Savagnier.* Those by the latter are to be noticed particularly for their good quality in connection with the very moderate prices charged.

F. P. INGOLD, *Chaux-de-Fonds.*

Fraises or cutters for finishing the teeth of wheels.

J. E. Antony-Bovy, *Chaux-de-Fonds.*

Watch-hands, stems, rings, detached parts for stem-winders, and steel wheels.

To mention fully the instances of ingenious contrivance and skillful execution of the mechanism shown in a collective exhibit of the productions of Swiss watch-makers is impossible in a brief report. The attention of the people of a considerable portion of Switzerland having been, for nearly two centuries, directed in this particular channel, all sorts of devices have been invented and re-invented. Whatever has been found to be of practical utility has been put into use, and what has proved to be impracticable has been laid aside. Not the least remarkable is the skill which they have shown in the production of watches which are really instruments of precision. In this they cannot, however, expect a monopoly; and whatever may be the result as to the crisis which now seriously disturbs their business, they can certainly expect to hold the undisputed control of the manufacture of all kinds of complicated watches. In this field of production they are without rivals.

REPORTS ON AWARDS.

GROUP XXV.

1. Atlantic and Pacific Telegraph Co., U. S.

EDISON'S AMERICAN AUTOMATIC TELEGRAPH.

Report.—It gives, on land telegraph lines of all lengths insulated on poles in the air, speeds of practical working which are from twofold to tenfold the speeds attained by the best of the other systems hitherto in use in America or any other part of the world. I have myself, in the general telegraph office of the Centennial Exhibition, Philadelphia, witnessed the receiving in fifty-seven seconds of one thousand and fifteen words from New York; and I retain for verification the slip on which the signals were received, and its transcription in ordinary writing by the receiving clerk. I am informed that the speeds actually obtained for satisfactory practical working through different lengths of telegraph line are as follows:

Length of line.	Practical working speed.
200 miles, ...	1000 words per minute.
300 "	500 " " "
400 "	250 " " "
600 "	150 " " "
1000 "	100 " " "

These important results are obtained by the simplest and surest of apparatus, and with remarkable economy of personal skill and labor. The system is Bain's original automatic system in all its beautiful simplicity. Where something of mechanical complication was needed for practical convenience, Mr. Edison has not shrunk from it, and he has given a perforating machine (all the details of which I have examined, and admired exceedingly), with a key for each letter, and one or two more keys for stops, etc., by which any unskilled person can punch his message on the sending slip with perfect sureness and accuracy at a slow speed, moderately skilled young operators at from twenty-five to thirty words per minute, and well-skilled first-class operators at sixty words per minute.

There is no other *mechanism* in the whole system, except the simplest of appliances worked by hand for pulling the sending slip and the receiving slip through the single instruments used at the two ends, whether for sending or receiving. Mr. Edison's double spring, with nickel rollers, seems a perfectly satisfactory solution of the problem of making the sending contacts for Bain's system in a trustworthy manner, which had been found very troublesome by many other inventors. In Mr. Little's resuscitation of Bain's system, from which Mr. Edison took his departure, various chemical solutions had been tried for moistening the receiving slip, and iodide of potassium had alone been found capable of marking the signals at the high speeds aimed at; but it was not found convenient for practical use, as the marks faded away too rapidly, sometimes before the message could be transcribed from the slip. On this important point I am favored with the following
by Mr. E. H. Johnson, who assisted Mr. Edison throughout all his experiments a

the practical development of the Bain automatic telegraph, and to whom I feel much indebted for very intelligent explanation of all the peculiarities of the system which has resulted from these labors and is now reported on for award: "All the iron-solutions recorded in the electrical books were tried repeatedly, but proved to be unequal to more than one hundred to one hundred and fifty words per minute. It became necessary, then, that a solution should be discovered having a sensitiveness near that of the iodide, without its fleeting character. Mr. Edison gave his attention thenceforth to chemistry and chemical experiments, and during six weeks of study and labor, day and night, made many thousands of different formulas, resulting at the end of that time in the discovery that ferrid-cyanide of potassium was almost as sensitive as the iodide, and that the record made upon it by an iron stilus was permanent, and had other good properties." The electro-magnetic shunt with soft-iron core, invented by Mr. Edison, utilizing Professor Henry's discovery of electro-magnetic induction in a single circuit to produce a momentary reversal of the line current at the instant when the battery is thrown off, and so cut off the chemical marks sharply at the proper instants, is the electric secret of the great speed he has achieved. The main peculiarities of Mr. Edison's automatic telegraph, shortly stated in conclusion, are, (1) the perforator, (2) the contact-maker, (3) the electro-magnetic shunt, and (4) the ferrid-cyanide of iron solution. It deserves award as a very important step in land-telegraphy.

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2. W. J. Philips, Telegraphic Director U. S. Centennial Exhibition (Fire-Alarm Telegraph), Philadelphia, Pa., U. S.

PHELPS AND PHILIPS' PRINTING TELEGRAPH INSTRUMENT.

Report.—This instrument embodies in compact form a receiving apparatus in print and by dial, and a transmitting apparatus, with key-board adapted to same; also a call-bell and key. The instrument operates rapidly and efficiently, does not require an experienced operator, is comparatively inexpensive in construction, and well adapted for general use, particularly on local lines.

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3. Alexander Graham Bell, Salem, Mass., U. S.

GRAHAM BELL'S ELECTRIC TELEPHONE AND MULTIPLE TELEGRAPH.

Report.—The idea of an electric telephone, or apparatus for transmitting sounds to a distance by variations of electric current through a wire, has been for many years before the world, and has been realized in several ways, differing considerably in details as to the appliances at two points of the circuit for producing the variations of electric current and for deriving perceptible effects from them. An extension of this idea to some kind of electro-phonetic telegraphy was inevitable, even though no one had thought it might or could lead to practically useful results. But the idea of a multiple electro-phonetic telegraphy, transmitting simultaneously several different musical notes, and using intermissions of these (like intermissions of currents in so many separate wires) for the simultaneous and independent transmission of different messages by one wire, is a very fine invention, of high scientific character, promising splendidly useful practical results.

This invention is claimed by Mr. Graham Bell, and he is entitled to full credit for it, even though, as I believe is the case, it has been also independently invented by others, both in England and America.

A very well worked-out realization of it is given in Mr. Bell's apparatus now exhibited. A great practical advantage of the electro-phonetic multiple telegraph over other methods of multiple telegraphy through one wire, is that no adjustment is required for varying conditions of the line to render the non-interference among the different messages perfect. Another even more important practical advantage is that it is indifferent between what points of the line and in which directions the different messages are being sent. The

different messages can, in fact, be transmitted from any different points of the line, and each may be read at all other stations (whether stations from which others of the messages are being sent or not) with practically perfect non-interference. Another important advantage is that earth currents and lightning discharges will never disturb the signaling.

Mr. Graham Bell's apparatus includes an ingenious and effective instrument for automatically making and breaking an electric contact every time one of his telegraphic musical notes commences and ceases to sound. Thus his multiple telegraph may be made self-recording (after the Morse or Bain method), or may be worked forward by relay through greater lengths of line than imperfectness of the insulation allows to be worked in one circuit. Mr. Bell showed me in action two of these electro-phonetic relays, recording quite independently the transmission of independent messages by two musical notes in one wire. In addition to his electro-phonetic multiple telegraph, Mr. Graham Bell exhibits apparatus by which he has achieved a result of transcendent scientific interest,—the transmission of spoken words by electric currents through a telegraph wire. To obtain this result, or even to make a first step towards it,—the transmission of different qualities of sound, such as the vowel sounds,—Mr. Bell perceived that he must produce a variation of strength of current in the telegraph wire as nearly as may be in exact proportion to the velocity of a particle of air moved by the sound; and he invented a method of doing so, a piece of iron attached to a membrane, and thus moved to and fro in the neighborhood of an electro-magnet, which has proved perfectly successful. The battery and wire of this electro-magnet are in circuit with the telegraph wire and the wire of another electro-magnet at the receiving station. This second electro-magnet has a solid bar of iron for core, which is connected at one end, by a thick disc of iron, to an iron tube surrounding the coil and bar. The free circular end of the tube constitutes one pole of the electro-magnet, and the adjacent free end of the bar-core, the other. A thin circular iron disc, held pressed against the end of the tube by the electro-magnetic attraction, and free to vibrate through a very small space without touching the central pole, constitutes the sounder by which the electric effect is reconverted into sound. With my ear pressed against this disc, I heard it speak distinctly several sentences, first of simple monosyllables, "To be or not to be" (marvelously distinct); afterwards sentences from a newspaper, "S. S. Cox has arrived" (I failed to hear the "S. S. Cox," but the "has arrived" I heard with perfect distinctness); then "City of New York," "Senator Morton," "The Senate has passed a resolution to print one thousand extra copies," "The Americans of London have made arrangements to celebrate the Fourth of July." I need scarcely say I was astonished and delighted; so were others, including some other Judges of our Group, who witnessed the experiments and verified with their own ears the electric transmission of speech. This, perhaps the greatest marvel hitherto achieved by the electric telegraph, has been obtained by appliances of quite a homespun and rudimentary character. With somewhat more advanced plans, and more powerful apparatus, we may confidently expect that Mr. Bell will give us the means of making voice and spoken words audible through the electric wire to an ear hundreds of miles distant.

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4. Elisha Gray and Samuel Stockton White, Chicago, Ill., U. S.

GRAY'S ELECTRIC TELEPHONE AND MULTIPLE TELEGRAPH.

Report.—The idea of an electric telephone, or apparatus for transmitting sound to a distance by variations of electric current through a wire, has been for many years before the world, and has been realized in several ways, differing considerably in details as to the appliances at two points of the circuit, for producing the variations of electric current, and for deriving perceptible effects from them. An extension of this idea to some kind of electro-phonetic telegraphy was inevitable, even though no one had thought it might or could lead to practically useful results. But the idea of a multiple electro-phonetic telegraphy transmitting simultaneously several different musical notes, and using intermissions of these (like intermissions of currents in so many separate wir ʼtaneous and

independent transmission of different messages by one wire, is a very fine invention of high scientific character, promising important useful practical results. This invention is claimed by Mr. Gray, and he is entitled to full credit for it, even though, as I believe is the case, it has been also independently invented by others, both in England and America. A very well worked-out realization of it is given in Mr. Gray's apparatus now exhibited. A great practical advantage of the electro-phonetic multiple telegraph over other methods of multiple telegraphy through one wire, is that no adjustment is required for varying conditions of the line to render the non-interference among the different messages perfect. Another even more important practical advantage is that it is indifferent between what points of the line and in which directions the different messages are being sent. The different messages can, in fact, be transmitted from any different points of the line, and each may be read at all other stations (whether stations from which others of the messages are being sent or not) with practically perfect non-interference. Another important advantage is that earth currents and lightning discharges will never disturb the signaling. The exhibitors, in their "Information for the Judges," say, "We are now able to equip a line for actual business, with a capacity for carrying through each wire eight messages simultaneously, and we see no reason why the number may not be increased to sixteen without difficulty." I quite concur in the latter part of this statement, and believe that sixteen or more messages could be usefully transmitted at the same time through one land telegraph wire of many hundred miles' length, by the apparatus actually exhibited by Mr. Gray. Mr. Gray's apparatus includes an ingenious and effective instrument for automatically making and breaking an electric contact every time one of his telegraphic musical notes commences and ceases to sound. Thus his multiple telegraph may be made self-recording (after the Morse or Bain method), or may be worked forward by relay through greater lengths of line than imperfectness of the insulation allows to be worked in one circuit. Mr. Gray gave, in the Exhibition building, an exceedingly interesting and pleasing demonstration of his apparatus in action, transmitting musical performances through the wire, and letting the result be heard with marvelous brilliance at the remote end in three different ways, one of which, founded on the remarkable property of electric currents to increase or diminish friction between a moist solid and a metal in contact, discovered by Mr. Edison and used by him in his electro-motograph, is, I believe, altogether original and novel in this electro-phonetic receiving instrument of Mr. Gray's.

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5. Western Union Telegraph Co., New York, N. Y., U. S.

PHELPS' PRINTING TELEGRAPH.

Report.—This instrument, founded on the same principle of chronometric telegraphy as the original Hughes printing instrument and the old military torch telegraph of the Greek general Æneas, is a great advance on the instrument known as the "combination instrument," in which some of the peculiarities of the Hughes and House instruments were combined. On some points it goes back advantageously to the simpler character of the original Hughes instrument, as, for instance, in dispensing with the plan of air-pressure introduced into the combination instrument, and performing the mechanical action by electro-magnetic power alone. It has the great advantage above all previous printing instruments of the chronometric class, of permitting groups of consecutive letters to be telegraphed by depressing simultaneously all the corresponding keys. Thus, if the keys A B are depressed simultaneously on the "combination instrument," the letters transmitted and printed are A F; if on the Phelps instrument, the result A B is correctly given. If all the letters of the alphabet are simultaneously depressed on the Phelps instrument, they are transmitted and printed in the order of the alphabet, and in the time of a single revolution of the type-wheel; and if any group of letters is simultaneously depressed, these letters are correctly transmitted and printed in the order in which they would be found in going through the alphabet in regular order. Thus, if the letters D A I L Y are

simultaneously depressed, the result is ADILY; but, to send the word "daily" correctly, all that is necessary is to first press the key D, then, as soon as it has marked, press A I L Y. The same manipulation would give this word correctly on the "combination instrument." But take the word "defiant." On the combination instrument, to send this word, the key D must first be depressed; when it has made its signal, E must be pressed, and the type-wheel runs round the alphabet through Z, A, and D, to E, till it prints E; then F must be pressed, and the wheel runs round once more before making the fresh signal; then I, and one more turn of the wheel; then A N T may be pressed simultaneously, and the word is completed while the type-wheel runs direct from A to T. On the Phelps instrument D E F I may be pressed simultaneously, and these letters are printed while the type-wheel runs from A to I; and next A N T depressed simultaneously finishes the word, as in the other instrument, while the wheel runs from A to T. Considering the enormous gain on this one word, and the continual occurrence of words in which more or less of such gain is attainable, I should expect to find that in practice the Phelps instrument would give an ordinary working speed quite as much as double that of the previous forms of instrument on the same chronometric principle, and I am not surprised to learn that, worked by expert operators, it can transmit from sixty to seventy words per minute. The Phelps electromotor (used also in the "Gold and Stock Transmitter," the subject of another award) is used to give the chronometric motions of the synchronous wheels of transmitter and receiver, in this instrument, and deserves special notice on account of the simplicity of the manner in which it gives the required degree of chronometric accuracy in virtue of its governor, a modification of Helmholtz's electro-magnetic governor.

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6. Western Union Telegraph Co., New York, N. Y., U. S.

QUADRUPLEX ELECTRIC TELEGRAPH.

Report.—The quadruplex system indicated by a set of instruments in the Western Union Telegraph Company's exhibition, though not actually shown in action, deserves an award on account of the great ingenuity, and possibly the great usefulness, of the method proposed. To send two distinct messages simultaneously in the same direction, a reversing key (R) and a simple Morse key (M) are used. The effect of depressing R is to reverse whatever battery is in series with the line. The effect of depressing M is to throw a certain number (p) of cells into series with the line in addition to a number (n) which is in series whether M is up or down. Thus, when M is up, the line has $+n$ or $-n$ in series with it, according as R is up or down. When M is down, there is $+(n+p)$ or $-(n+p)$, according as R is up or down. The remote end receives every current through a polarized relay (such as Siemens'), which marks R's signals but is uninfluenced by M's; and a common, non-polar relay or sounder, which marks M's signals but is uninfluenced by the reversals which constitute R's signals. The non-polar relay must be adjusted to keep one position under the influence of $\pm n$, and its other position under the stronger influence, $\pm(n+p)$. The adjustments required for this system are clearly easy in practice. Duplex it by either of the old well-known methods, and we have the "quadruplex;" but then the adjustments become very difficult, and may be impracticable for useful work on any long line.

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7. Partrick & Carter, Philadelphia, Pa., U. S.

TELEGRAPH SOUNDERS, LEARNER'S APPARATUS, AND HOTEL ANNUNCIATORS.

Report.—One of the products exhibited is a very powerful sounder (receiving instrument), well designed to give a powerful sound, and well executed. A complete learner's apparatus, Morse-key and sounder, very economically made, and sold at a remarkably low price, yet thoroughly effective, is also exhibited. Also a good hotel annunciator of the simplest design, electrical and mechanical.

8. Watts & Co., Baltimore, Md., U. S.

ELECTRIC ANNUNCIATORS.

Report.—The annunciators exhibited include one remarkable form, in which as many as nine different messages are provided for, so that a person touching one or other of nine different buttons, opposite to which the different messages are written, sends the one of them which he desires to send. The message thus sent is shown by a clear indicator at the service station. The design and execution of the electric and mechanical details seemed good. The usefulness of this system for hotels, large private houses, public offices, places of business, etc., is obvious.

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9. William B. Watkins, New York, N. Y., U. S.

INSTRUMENTS OF THE AUTOMATIC SIGNAL TELEGRAPH CO.

Report.—The principal object exhibited is a very complete system of automatic fire-alarm telegraph. In this a strip of two metals of different expansibilities makes a contact when heated to a certain degree. This "thermostat" is very sure in its action, probably more so than the form in which the expansion of mercury is used. The arrangements exhibited for signaling automatically the precise locality of the fire (the house, and the floor, and even the very room of the house) are very complete and effective, provided the line is well insulated. A complete metallic circuit through all the buildings of a district is used to show at any moment a failure, should there be a failure, of continuity or insulation at any point of the line, and at the same time to retain efficiency for alarm from any of the houses, even though there be a complete break at any one point of the line.

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10. Washburn & Moen Manufacturing Co., New York, N. Y., U. S.

GALVANIZED TELEGRAPH WIRE.

Report.—The large quantity of wire exhibited is excellent in appearance, being nearly smooth and cylindrical and free from flaws. Careful tests, made from time to time by disinterested parties, indicate that the product is of established value, possessing a high degree of tensile strength, pliability, and extensibility, with comparatively low electrical resistance relative to the weight per mile.

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11. Welch & Anders, Boston, Mass., U. S.

ANDERS' MAGNETO-PRINTING TELEGRAPH INSTRUMENT.

Report.—This telegraph instrument is of particularly simple construction, and is thus very little liable to get out of order. No voltaic battery is used, and the signals are made by electro-magnetic action, without any making and breaking of contacts. The instrument runs very easily, and the manipulation is easy and sure; thus it is very suitable as a private telegraph for places of business and dwelling-houses.

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12. Western Electric Manufacturing Co., Chicago, Ill., U. S.

BROOKS INSULATORS.

Report.—The Brooks insulator, from the mode in which it is incased in iron, and supported, has great strength, and is particularly safe against damage from missiles or from any strain which it can receive from the strongest telegraph wire. Its insulating quality in rain and fogs is greatly superior to that of almost all other forms of insulators used for telegraph wires in any part of the world. In respect to combining the two qualities of great strength and high insulation, it is, so far as I know, superior to any other insulator.

13. **Western Electric Manufacturing Co., Chicago, Ill., U. S.**

THE NEEDLE ANNUNCIATOR, MERCURIAL FIRE-ALARM, AND ELECTRIC BELLS.

Report.—Commended for excellence of design and workmanship. The fire-alarm exhibited acts by the expansion of mercury in an hermetically-sealed glass vessel, producing metallic connection between two platinum wires.

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14. **Western Electric Manufacturing Co., Chicago, Ill., U. S.**

GRAY'S PRINTING TELEGRAPH.

Report.—This instrument is suited for use in places of business, public offices, and private houses, being worked with ease and accuracy by persons not practiced in telegraphy, and without special capacity for acquiring skill. A battery of eleven small gravity cells is used for main line up to forty miles' distance, and four-cell local battery for each receiving station. The arrangements for working contacts, and automatic adjustment, are well designed for convenience and security in ordinary, and the general design and workmanship of the instrument are good.

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15. **Western Electric Manufacturing Co., Chicago, Ill., U. S.**

ELECTRIC RAILWAY SIGNALS.

Report.—By a well-designed system of electric connections, in a circuit completed through the rails of the road and the axles of the carriage or carriages, an alarm-signal or safety-signal, as the case may be, is sounded or exhibited, or both sounded and exhibited, when a train is upon a certain section of the line in the neighborhood of the signal station. An award is deserved on account of usefulness of the object proposed, and the promise of practical success which the details of the method illustrated by the model exhibited justify.

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16. **National Fire-Alarm Co., Richmond, Ind., U. S**

FIRE-ALARM AND POLICE TELEGRAPH.

Report.—Commended for good mechanical and electrical arrangements for fire-alarms, including a mechanical relay of good design and construction for striking alarm-bells in fire stations or in church towers.

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17. **Saml. Gardiner, Washington, D. C., U. S.**

ELECTRIC GAS-LIGHTING APPARATUS IN WOMEN'S PAVILION AND HORTICULTURAL BUILDING.

Report.—It is a most useful invention, being a thoroughly practical, economical, and convenient mode of lighting gas by sparks from an induction coil.

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18. **Holmes Burglar-Alarm Telegraph Co., New York, N. Y., U. S.**

BURGLAR-ALARM TELEGRAPH.

Report.—Commended for good design and workmanship in electric hotel and house annunciators and burglar-alarm telegraphs; also a bank-safe telegraph, with a peculiar and effective arrangement, which, by double panels with sheets of tin-foil between, produces an electric contact when the panel of the door is pierced or broken or cut into, and so gives the alarm.

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19. **Wallace & Sons, Ansonia, Conn., U. S.**

FARMER'S MAGNETO-ELECTRIC MACHINE.

Report.—Mr. Farmer's magneto-electric machine is founded on the remarkable important principle, first introduced, I believe, by Siemens, of using an electro-magnet with magnetism sustained by the induced current for producing the magneto-electric induction which main-

tains the current. It was exhibited in action, producing a very powerful electric light; a powerful and well-made machine, differing considerably from Gramme's, and worthy of rigorous experimental comparison with Gramme's.

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20. Gold and Stock Telegraph Co., New York, N. Y., U. S.

GOLD AND STOCK TRANSMITTER.

Report.—This very remarkable instrument, invented by Geo. M. Phelps, is adapted to transmit and to record, automatically, the prices of gold and stocks from a central office to any number of branch offices or private places of business simultaneously. The complicated practical problem proposed is skillfully treated and solved in a thoroughly useful manner in Mr. Phelps' instrument.

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21. A. G. Walcker, Paris, France.

PNEUMATIC TELEGRAPH—"SONNERIE À AIR."

Report.—Commended for the usefulness of the pneumatic telegraph and excellence of its manufacture by Mr. Walcker, who has not only supplied it for use in hotels and places of business and private houses, where in many cases it is found more economical than electric bells, but has also adapted it for signaling on board ship, and supplied it to several iron-clads of the French and Russian navies.

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22. Kuntze & Co., Stockholm, Sweden.

PNEUMATIC TELEGRAPH.

Report.—Commended for usefulness of the pneumatic telegraph and excellence of its manufacture by Messrs. Kuntze & Co., for call-bells and other signals within a house, or generally for small distances.

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23. Jos. Zimber, Furtwangen, Germany.

PNEUMATIC TELEGRAPH.

Report.—This is a very simple and ingenious invention for transmitting a small power to a distance for the purpose of signaling, and other objects. It consists essentially of a long tube of india-rubber or lead, with an elastic rubber bottle at one end, and a cylindrical bellows at the other. When the bottle or bag is compressed in the hand, an impulse through the air is transmitted to the other end of the tube, and, by expanding the bellows, moves a ratchet, which gives motion to a wheel, which, in turn, moves the hammer of a bell. By this apparatus air is employed instead of electricity for sending signals in hotels, in giving simultaneous motion to clocks in different apartments, for informing the conductor of a train of an accident on any car of several, for directing the steering of a vessel, and for opening and closing doors.

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24. Gramme Magneto-Electric Machine Co., Paris, France.

GRAMME MAGNETO-ELECTRIC MACHINES.

Report.—Several specimens of the well-known Gramme machine, without steel magnet, constitute this collection, and some of them were shown in action producing the electric light. The fundamental peculiarity of the Gramme machine, an excellent and very original disposition of the movable coils on a soft iron ring placed between the poles of a magnet, by which not only is an almost perfect uniformity of electro-motive force and resistance obtained, but also, I believe, a very high degree of electro-dynamic economy, deserves

warmest approval. The Gramme machines of this collection are interesting also as an example of the method, introduced first, I believe, by Siemens, in which the inducing magnetism is sustained by the current which it induces. If such a machine, with its circuit complete, is given with absolutely no residual magnetism in its iron, and no external magnetizing force (not even that of terrestrial magnetism) influencing it, it might be turned at any speed, however rapid, without exciting any electric current or producing any magnetization; and unless the speed exceeds a certain limit, this electric quiescence and magnetic neutrality is a condition of stable equilibrium. But if the speed exceeds a certain limit, which in Gramme's machine, as in Siemens', is much smaller than any of the ordinary working speeds, the condition of electric quiescence and magnetic neutrality is a condition of unstable equilibrium. An infinitesimal magnetization of the iron, by the feeblest external magnetizing force, or an infinitesimal current through the circuit produced by any electro-motive agency (such as might be produced by a difference of temperatures between junctions of different metals in the circuit), would at once determine a current in one direction or the other, which would be very rapidly increased until in a short time it would sensibly reach a limit depending on the speed at which the machine is kept running. The electromotive force induced by the motion is expressible by the following formula:

$$N\,(M + c\gamma),$$

where N denotes the number of revolutions per unit of time, M a quantity depending on the magnetism of the iron, c a constant depending on the forms and dimensions of the coils, and γ the strength of the current actually flowing through the coils. Hence, if R be the resistance of the circuit, we must have

$$\gamma = \frac{N\,(M + c\gamma)}{R}.$$

Now, supposing the magnetism of the iron to depend wholly on the magnetizing force of the current, and neglecting magnetic retentiveness, we have

$$M = CI\gamma,$$

where C is a constant depending on the machine, and I is the magnetic inductive capacity of the iron, or a mean effective magnetic inductive capacity when the current is (as will generally be the case) so strong as to render the inductive capacity different in different parts. We must regard I generally as a quantity varying with γ, which is always positive, which is constant (call it I_0) for very small values of γ, and which ultimately varies as $\frac{1}{\gamma}$ wnen γ is infinitely great. Thus, we see that for very small values of γ there can be no equilibrium, except with $\gamma = 0$, and the equilibrium is unstable unless

$$N < \frac{R}{CI_0 + c}.$$

When $N > \frac{R}{CI_0 + c}$, the current rises (from any infinitesimal beginning in either direction) till I becomes so small as to make

$$N = \frac{R}{CI + c}.$$

If $N > \frac{R}{c}$ the current would increase without limit, and the coils would inevitably be melted, however energetic the refrigerating agency applied to keep them cool. But for the highest extreme practical speeds of the machine it is certain that $N < \frac{R}{c}$, and the current attained is practically fixed by some moderate reduction of I towards its ultimate zero. The law according to which the strength of the current augments with the revolutional speed of the machine is a very interesting and important subject for scientific inquiry. Besides these highly interesting scientific relations, the Gramme machines exhibited have practical applications to electro-metallurgy, to light-houses, to steamers' mast-head lights, and possibly also to the town and house lighting of the future.

25. Joint Stock Company for Telegraph Supplies, Berlin, Germany.

INSULATORS.

Report.—The best European types of insulators are shown, manufactured in a thoroughly satisfactory manner, in this collection. It includes Latimer Clark's double drip insulator, with General Von Chauvin's improvements of form and mounting, by which it has become one of the most perfect, if not the most perfect, of all insulators for rainy and foggy conditions of atmosphere; Siemens' insulator, with its high insulating quality and great strength to resist mechanical violence; and very excellent and convenient forms of insulator for office connections.

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26. India-Rubber, Gutta-Percha, and Telegraph Works Co. (Limited), London, England.

INDIA-RUBBER AND GUTTA-PERCHA GOODS, TELEGRAPH SUBMARINE CABLES, AND TELEGRAPH STORES OF ALL DESCRIPTIONS.

Report.—Commended for good manufacture of india-rubber and gutta-percha goods, of insulated wire for submarine cables, torpedo telegraph cables, and subterranean telegraph cables, and of iron-sheathed insulated wire forming completed submarine cable of the several types suitable for "deep sea," "intermediate," and "shore-end" cable. Of the excellence of one of these cables, made and laid by this Company, I can testify from personal knowledge, having tested electrically their Direct Spanish cable during six months after its submergence, and found it perfect.

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27. Siemens Brothers, London, England.

SUBMARINE TELEGRAPH CABLES.

Report.—The specimens exhibited represent cables which have been made and laid by Messrs. Siemens for the River Plate and Brazil Telegraph Company, and the Direct United States Cable Company, and which are now in successful operation between Rio Janeiro, Santos, Santa Catarina, Rio Grande do Sul, and the southern frontier of Brazil, and between Ireland and the United States. As to the excellent quality of these cables I can testify from personal knowledge, having been one of the engineers of the River Plate and Brazil Telegraph Company, and in this capacity responsible for inspection and testing of the cables during the manufacture and laying, and having personally tested the Direct United States cable after its submergence.

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28. Telegraph Construction and Maintenance Co. (Limited), London, England.

SPECIMENS OF SUBMARINE TELEGRAPH CABLES.

Report.—The specimens exhibited represent successful cables which have been laid by the Telegraph Construction and Maintenance Company in all parts of the world, including the Atlantic cables of 1865–66, and 1866; the cables joining England and France through the Mediterranean with Malta and Alexandria; the Red Sea and the Aden-Bombay cables, completing (with the land line over the Isthmus of Suez) the communication between England and India in one unbroken line through Gibraltar; the cables connecting India with China and Australia; and, lastly, the cable connecting Australia and China. Thus, through the work of this Company, there is, at present, communication round the East between America and New Zealand. Of the electrical and mechanical excellence of several of these cables I can testify from personal knowledge, having been honorary consulting electrician to the Atlantic Telegraph Company, and having afterwards for a time acted on the scientific staff of the Telegraph Construction and Maintenance Company.

29. Breguet, Paris, France.

GRAMME MAGNETO-ELECTRIC MACHINES WITH STEEL MAGNETS.

Report.—The Gramme machine, with Jamin's form of steel magnet, is well known as the best or among the best of magneto-electric machines in which the inductive action depends on permanent magnets. It becomes an electro-magnetic engine, and probably one standing high in point of economy of power, when a current is sent by a battery through the circuit. It presents an interesting illustration of electric transference of power when two of the machines are put in circuit with one another, and one of them turned; the other, by the electro-magnetic action of the current thus sent through it, turns of itself if left free.

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30. Austin G. Day, New York, N. Y., U. S.

KERITE INSULATED TELEGRAPH WIRE.

Report.—Commended for excellence of the insulation, and durability of the insulator, in some of the circumstances in which gutta-percha and india-rubber of the various preparations hitherto applied have been found to fail. The kerite insulation has also proved successful in several short cables under rivers and sea.

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31. Gamewell & Co., New York, N. Y., U. S.

THE AMERICAN FIRE-ALARM AND POLICE TELEGRAPH, IN TELEGRAPH DEPARTMENT.

Report.—This is the great American system of fire-alarm originated in Boston, Massachusetts, by Dr. Wm. F. Channing and Moses G. Farmer, in 1851, and, with many improvements and developments, is now in use, as I am informed, in seventy-eight cities in the United States and Canadas. The collection of electro-magnets locked in a glass case at the central station, with its arrangements for non-interference called an "automatic non-interference repeater," is a very admirable piece of electrical mechanism, so designed as to facilitate the dividing of the city into any number of independent circuits, yet not allowing derangement on one circuit to affect the integrity of the other circuits, also preventing the signals on one circuit from interference by action on the others. The signal station boxes are also automatic and non-interfering; an alarm sent from one is transmitted through the automatic non-interference repeater to all the independent circuits and sounded through electro-mechanism upon all the bells and gongs and in all the signal boxes throughout the city, repeating at proper intervals the station number as many times as may have been considered desirable. When an alarm sent from any signal box is going through, and an attempt is made to send one from another, it will not be permitted to go through, in consequence of the non-interference arrangements in the repeater and boxes mentioned above. The person giving an alarm knows that it has gone out correctly by hearing the station number sounded on a small bell in the box he is at.

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32. George A. Dowden, Newark, N. J., U. S.

BURGLAR ALARM AND AUTOMATIC ANNUNCIATOR.

Report.—The apparatus, by an electric contact for ringing a bell when a window or door is opened and marking on an annunciator the number specifying the exact place of the disturbance, is substantial and effective. The bell thus started automatically is kept ringing until heard and stopped. A conveniently arranged silent indicator may be examined at any time to see that the house is all closed, and the battery may be tested, to make sure of efficiency, without giving the alarm.

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33. American District Telegraph Co.

IMPROVED GRAVITY BATTERY; DISTRICT TELEGRAPH APPARATUS.

Report.—"Lockwood's Improved Gravity Battery" is exhibited. It is beautifully simple and effective. Crystals of sulphate of copper, occupying the lower part of a tall glass cell,

disappear gradually in the course of a year or so of ordinary use of the battery, and an equivalent of sulphate of zinc fully dissolved is found uniformly diffused through the whole liquid. If worked too hard, dense solution of sulphate of zinc would fall from the zinc (which is in the upper part of the cell) and mix up with the sulphate of copper too much; but the condition of cells which had been in use for ten months, and which I examined, proved that this is not the case in the ordinary telegraph use of the battery. Well-arranged systems of district telegraph for calling police, calling a messenger, or giving an alarm of fire, are also exhibited. Also an excellent thermostat, consisting of a spiral of a slip of two metals of different expansibilities united properly. The electric system uses purely metallic circuit, and in this respect is certainly better than systems in which "grounds" are used for making the signals.

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34. Mason & Hamlin Organ Co., Boston, Mass., U. S.

REED ORGANS AND HARMONIUMS.

Report.—That their exhibit of reed organs and harmoniums shows instruments of the first rank in the several requisites of the class, viz.: smoothness and equal distribution of tone, scope of expression, resonance and singing quality, freedom and quickness in action of key and bellows, with thoroughness of workmanship combined with simplicity of action.

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35. George Steck & Co., New York, N. Y., U. S.

GRAND, SQUARE, AND UPRIGHT PIANOS.

Report.—Commended for power and pleasing quality of tone, pliable action, and solid workmanship. Shows novelty of construction in an independent and iron frame, placing strings in three tiers.

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36. Charles M. Stieff, Baltimore, Md., U. S.

ONE GRAND-CONCERT AND ONE SQUARE PIANO.

Report.—Commended for powerful tone in the square piano, and good workmanship.

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37. Wm. F. & H. Schmoele, Philadelphia, Pa., U. S.

ORCHESTRION.

Report.—Commended for novelty of invention and ingenuity in arrangement.

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38. Schomacker Piano-Forte Manufacturing Co., Philadelphia, Pa., U. S

GRAND, SQUARE, AND UPRIGHT PIANOS.

Report.—Commended for power of tone, general good construction, and workmanship.

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39. C. F. Zimmermann, Philadelphia, Pa., U. S.

ACCORDIONS AND CONCERTINAS.

Report.—Commended for good workmanship and pleasing tone

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40. Browne & Buckwell, New York, N. Y., U. S.

HARP.

Report.—Commended for good tone and excellence in workmanship.

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41. Alfred Dolge, New York, N. Y., U. S.

PIANO FELTS OF EVERY KIND, AND SOUNDING-BOARD WOOD.

Report.—Commended for excellence of workmanship.

42. John William Otto, St. Louis, Mo., U. S.

ONE SEMI-UPRIGHT PIANO-FORTE.

Report.—Commended for novel and intelligent construction, in combining the upright with the square form of the instrument.

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43. Munroe Organ Reed Co., Worcester, Mass., U. S.

ORGAN REEDS.

Report.—Commended for good finish and workmanship.

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44. James McDonald, Agent of McDonald Piano-Forte Manufacturing Co., Williamsport, Pa., U. S.

SQUARE PIANO-FORTES.

Report.—Commended for fullness and evenness of tone and general good quality of workmanship.

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45. Clough & Warren Organ Co., Detroit, Mich., U. S.

REED ORGANS.

Report.—Commended because their instruments exhibited good quality of tone, with volume and purity, having the character of the diapason in the ordinary organ, and because of certain mechanical arrangements which facilitate the working of the instruments, together with neatness of design and ornament, combined with simplicity in construction.

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46. Burdett Organ Co., Erie, Pa., U. S.

REED ORGANS.

Report.—Commended because of the variety and good quality of the tones produced, and success in voicing; because of the number and novelty of stop combinations, and of the general power, capacity, and effects produced. The work in all its details is performed at the manufactory of the exhibitors.

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47. A. Faas & Co., Philadelphia, Pa., U. S.

SQUARE PIANO.

Report.—Commended for strong, good quality of tone, touch, and workmanship.

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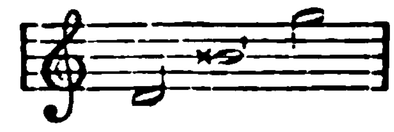
48. Henry McShane & Co., Baltimore, Md., U. S.

A CHIME OF THIRTEEN (13) BELLS. 

Report.—Commended because of excellence in casting, general accuracy of tone, though mounted as they came from the moulds, with no special tuning; because of the convenient method by which the chime is played, and because of the application of the rotary yoke, by means of which new points are secured for the impact of the tongue.

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49. Conrad Meyer & Sons, Philadelphia, Pa., U. S.

SQUARE PIANO-FORTES.

Report.—This firm exhibited new piano-fortes of the square form, and an old six-octave instrument made by the senior member of the firm in 1832, and publicly exhibited by him at the Franklin Institute in Philadelphia in 1833. It was shown by incontestable evidence that this instrument contained the elements of the first full cast-iron frame introduced at that date, and substantially in the same form as used in all American square piano-fortes from that time.

50. Kranich & Bach, New York, N. Y., U. S.

GRAND, SQUARE, AND UPRIGHT PIANOS.

Report.—Commended for strong pleasing tone and good workmanship.

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51. Kriegelstein & Co., Paris, France.

TWO UPRIGHT PIANOS—ONE WITH VERTICAL AND ONE WITH SEMI-OBLIQUE SCALE.

Report.—Commended for clear tone, pliable touch, and smooth finish. Shows action in Steinway system.

---

52. Hinzen, Rosen, & Co., Louisville, Ky., U. S.

SQUARE PIANO.

Report.—Commended for good tone and touch, together with good workmanship.

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53. Hazelton Bros., New York, N. Y., U. S.

GRAND AND UPRIGHT (ONLY) PIANO-FORTES.

Report.—Commended for their elastic touch, singing quality, delicacy and power of tone, with excellence of workmanship.

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54. Peloubet, Pelton, & Co., New York, N. Y., U. S.

REED ORGANS.

Report.—Commended because the reed organs exhibited by them, being of their ordinary product for the market, were instruments of excellent and even quality of tone, sonorous yet delicate, and giving a desirable variety in expression. They were also of good workmanship, and were quiet in action of bellows and keys.

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55. P. Brantzeg, Christiania, Norway.

UPRIGHT PIANO.

Report.—Commended for tone, touch, and workmanship.

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56. J. G. Malmsjö, Göteborg, Sweden.

PARLOR-GRAND AND UPRIGHT PIANOS.

Report.—Commended for power, good quality of tone, easy touch, and good workmanship.

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57. Weber & Co., Kingston, Ontario, Canada.

SQUARE PIANO.

Report.—Commended for tone, touch, and workmanship.

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58. Dominion Organ Co., Bowmanville, Ontario, Canada.

REED ORGANS.

Report.—Commended because they have produced in their instruments a pure and satisfying tone by their method of voicing, and have a simple and efficient stop-action, with satisfying musical combinations, an elastic touch, and good general workmanship.

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59. Achille Parise Son, Naples, Italy.

ONE PIANOGRAPHE.

Report.—Commended because of great ingenuity exhibited in its mechanism and construction, its object being to record immediately whatever notes may be played upon the piano-forte.

60. Hermann Koch, St. Petersburg, Russia.

PARLOR-GRAND PIANO, AND INTERIOR CASE WITH DOUBLE SOUNDING-BOARD OF NOVEL CONSTRUCTION IN POSITION.

Report.—Commended for sweetness and singing quality of tone, with excellence of workmanship.

---

61. Krall & Seidler, Warsaw, Russia.

PARLOR-GRAND PIANO-FORTE.

Report.—Commended for its power and quality of tone, its elasticity of touch, and smoothness of finish.

---

62. Decker Bros., New York, N. Y., U. S.

GRAND, SQUARE, AND UPRIGHT PIANOS.

Report.—Commended for power, evenness of tone, precision and elasticity of touch, with great excellence of workmanship and intelligence in construction.

---

63. Hallet, Davis, & Co., Boston, Mass., U. S.

GRAND, UPRIGHT, AND SQUARE PIANOS.

Report.—Commended for volume of tone, good construction, and excellence of workmanship; and because of originality of design and artistic skill in their upright instrument, with ingenious combination of mechanical devices for securing permanence in tune.

---

64. J. Jacques Adank & Co., St. Croix, Switzerland.

MUSICAL BOXES.

Report.—Commended for fine and sweet tone and good workmanship.

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65. C. Paillard & Co., St. Croix, Switzerland.

MUSICAL BOXES.

Report.—Commended for good quality of tone and workmanship.

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66. B. A. Brémond, Geneva, Switzerland.

MUSICAL BOXES.

Report.—Commended for good workmanship and pure tone.

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67. S. Karrer, Teufenthal, Aargau, Switzerland.

MUSICAL BOXES.

Report.—Commended for good workmanship and sweet tone.

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68. Karrer & Co., Teufenthal, Aargau, Switzerland.

MUSICAL BOXES.

Report.—Commended for pleasing tone and good workmanship.

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69. J. Trost & Co., Zürich, Switzerland.

UPRIGHT PIANO.

Report.—Commended for good tone, pleasant touch, and workmanship.

70. M. Pohlman, Nuremberg, Germany.

PIANO-FORTE WIRE.

Report.—Commended because he presented the best quality of music wire showing the greatest tensile strength.

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71. P. J. Trayser & Co., Stuttgart, Germany.

REED ORGANS.

Report.—Commended because the organs exhibited by them were of excellent workmanship, with a smooth, delicate, rich tone, evenly distributed.

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72. M. Welte & Sons, Freiburg, Germany.

ORCHESTRION, PLAYING SIX OVERTURES.

Report.—Commended for a powerful tone and perfection in mechanism.

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73. Schlessiger & Lummer, Gera, Germany.

PIANO LEATHER.

Report.—Commended for excellence in tanning buckskins.

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74. Ed. & Wilhelm Geyer, Eisenberg, Germany.

PIANO LEATHER.

Report.—Commended for excellence in tanning buckskins.

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75. E. F. Walcker & Co., Lüdwigsburg, Germany.

ONE CHURCH ORGAN.

Report.—Commended because it is an instrument of highest excellence in all that may be demanded of its class, combining power of utterance with delicacy, richness, and brilliancy of tone, with a blending quality through all its registers, no one stop pronouncing itself above its fellows, the individuality of each being preserved. Its touch is sharply responsive under all connectings, its elasticity being secured by the novel invention of the conical valve system. The materials used are of superior quality, while all the details of construction give token of skill and faithful work.

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76. Gilbert L. Bauer, London, England.

ONE HARMONIUM.

Report.—Commended for its powerful yet sweet and even tone and excellent workmanship.

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77. B. Shoninger Organ Co., New Haven, Conn., U. S.

REED ORGANS.

Report.—Commended because the company manufactures good instruments at a price rendering them possible to a large class of purchasers, the instruments having a combination of reeds and bells, producing novel and pleasing effects.

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78. Altenburg & Graue, Bremen, Germany.

UPRIGHT PIANO.

Report.—Commended for good tone and workmanship.

79. Eduard Seiler, Liegnitz, Germany.

UPRIGHT PIANO.

Report.—Commended for strength and singing quality of tone and pleasant touch, together with cheapness in cost of production.

80. F. L. Neumann, Hamburg, Germany.

UPRIGHT PIANOS.

Report.—Commended for good tone and workmanship, combined with cheapness in cost of production.

81. Ernst Kaps, Dresden, Germany.

PARLOR-GRAND PIANO-FORTES.

Report.—Commended for good quality of tone and easy touch. The strings are placed in three separate tiers.

82. Rud. Ibach's Son, Barmen, Germany.

GRAND AND UPRIGHT PIANOS.

Report.—Commended for good singing quality of tone, and workmanship.

83. Julius Blüthner, Leipsic, Germany.

GRAND AND UPRIGHT PIANOS.

Report.—Commended for excellent quality of tone, superior workmanship, precision of action, and novel construction in grand pianos, being an attachment to the treble, called "Aliquot."

84. G. Schwechten, Berlin, Germany.

UPRIGHT PIANO.

Report.—Commended for power and good quality of tone, easy touch and good workmanship, combined with cheapness.

85. Jno. Brinsmead & Sons, London, England.

PARLOR-GRAND AND TWO UPRIGHT PIANOS CONTAINING OLD SYSTEM OF PARALLEL STRINGS.

Report.—Commended for good quality of tone, pliable touch, and excellence of workmanship. Action shows a simplified system of escapement.

86. Hilborne L. Roosevelt, New York, N. Y., U. S.

CHURCH ORGAN.

Report.—Commended because the instrument (one of very large dimensions, with three manuals) is of good materials and skillful workmanship, exhibiting thoughtful ingenuity in its mechanism and construction, and in its grouping of facilities for the player. Its touch is light under every burden, its tones rich and delicate yet firmly pronounced, the voicing that of the English system, being equable and not sacrificing the characteristics of the several registers to the power of the whole. The yield of sound in full blending is grandly effective. It has a convenient system of changeable combination pedals, with novel wind-chest and draw-stop action. Another novelty is its means of producing echo effects by the application of electricity.

87. E. & G. G. Hook & Hastings, Boston, Mass., U. S.

ONE LARGE AND THREE SMALL CHURCH ORGANS.

Report.—Commended because the principal instrument (being of largest dimensions, with four complete manuals) is of the highest rank in its class, the materials employed of excellent quality, utilized with skill, ingenuity in arrangement, and versatility in combination. Its foundation registers are rich and far-reaching in tone, of a pure diapason quality, and of excellent qualifying power. The tones of the four-feet, the two-feet, and mixture, are brilliant without shrillness, the reeds full and resonant. The resources for solo-work are ample, their individual characteristics well pronounced, while the combination of the entire force of the instrument gives forth an effective and solemn majesty of sound. The other three organs, each of much merit, are of the ordinary product of the manufactory of the firm, and are intended for churches of small dimensions.

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88. Albert Weber, New York, N. Y., U. S.

GRAND, SQUARE, AND UPRIGHT PIANOS.

Report.—Commended for sympathetic, pure, and rich tone, combined with greatest power, as shown in a grand piano of large dimensions. These three styles, grand, square, and upright, show intelligence and solidity in their construction, a pliant and easy touch, which at the same time answers promptly to its requirements, together with excellence of workmanship.

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89. Steinway & Sons, New York, N. Y., U. S.

GRAND, SQUARE, AND UPRIGHT PIANOS.

Report.—Commended for greatest concert capacity in grand pianos, as also highest degree of excellence in all their styles of pianos, viz., largest volume, purity and duration of tone, and extraordinary carrying capacity, with precision and durability of mechanism; also novel disposition of the strings, and construction and bracing of the metal frame.

Improvements applied by Steinway & Sons were the following:

1st. A disposition of the strings in the form of a fan, placing the bass strings across the steel strings, and materially elongating the sound-board bridges by moving them nearer to the centre of the sound-board itself, thus setting greater portions of the latter into vibratory action, and so producing a greatly increased volume of sound.

2d. A duplex scale, patented in 1872, brings into action those portions of the strings which heretofore lay dormant and inactive, thereby increasing the richness, pliability, and singing quality, as well as the carrying capacity of the tone, especially of the upper notes.

3d. A cupola metal frame, patented in 1872 and 1875, with its new system of a cross-bar and bracings, giving absolute safety against the pull of the strings, and increasing the capacity to stand in tune. The space gained by the use of the capo-d'astro bar permits the use of more heavily felted hammers, whereby a pure, rich quality of tone is retained much longer than heretofore.

4th. A construction of the sound-board, with its system of compression (as shown in the patents of 1866, 1869, and 1872), preventing that relaxation of the sound-board which is the natural result of its constant concussion caused by the strokes of the hammers against the strings, and by atmospheric influences.

5th. A metallic tabular frame action (patented in 1868 and 1875), being entirely impervious to atmospheric influences, in conjunction with the new system of escapement, resulting in unerring precision, power, and delicacy of touch, and durability.

6th. A tone-sustaining pedal (patented 1874) extends the capacity of the piano for the production of new musical effects, by enabling the performer, at pleasure, to prolong the sound of a single note or groups of notes, leaving both hands free to strike other notes; is of simple construction, not liable to get out of order, and its use easily acquired.

90. John Pfaff, Philadelphia, Pa., U. S.

FLUTES AND CLARIONET.

Report.—Commended for novelty in making the mouth-piece, and good workmanship.

---

91. Anton Siebenhühner, New York, N. Y., U. S.

THREE VIOLINS.

Report.—Commended for good workmanship and a fine singing tone.

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92. William Seefeldt, Philadelphia, Pa., U. S.

BRASS INSTRUMENTS.

Report.—Commended for good powerful tone and nioe finish.

---

93. John Albert, Philadelphia, Pa., U. S.

VIOLINS, VIOLAS, CONTRABASS, AND CITHERAS.

Report.—All the instruments were well made, of good, clear, resonant tone.

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94. Charles F. Albert, Philadelphia, Pa., U. S.

VIOLINS, VIOLONCELLO, AND VIOLA.

Report.—The quartette of instruments was of exceptionally good quality, and of workmanlike skill.

---

95. Joseph Neff, Philadelphia, Pa., U. S.

TWO VIOLINS, ONE VIOLA, AND ONE VIOLONCELLO.

Report.—The quartette of instruments presented was of pure resonant tone, and of excellent workmanship and make.

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96. George McFadden, Syracuse, New York, U. S.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for strength, finish, and cheapness.

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97. W. E. Barton, East Hampton, Conn., U. S.

HOUSE, TABLE, AND SLEIGH BELLS.

Report.—Commended because of excellence in castings and finish of workmanship, clearness and resonance of tone.

---

98. Bacon & Karr, New York, N. Y., U. S.

SQUARE AND UPRIGHT PIANOS.

Report.—Commended for strength and evenness of tone, pleasant touch, and smooth finish.

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99. Henry G. Lehnert, Philadelphia, Pa., U. S.

COLLECTION OF BRASS INSTRUMENTS, CYMBALS, AND GONGS.

Report.—Commended because the instruments were of excellent finish of workmanship, power, clearness and resonance of tone, and great facility of manipulation.

100. Aug. Gemünder, New York, N. Y., U. S.

CONTRABASSO.

Report.—Commended in that the instrument presented was of good and powerful tone, well made, and of rarely excellent qualities.

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101. J. dos Santos Couceiro, Rio de Janeiro, Brazil

VIOLINS AND GUITARS.

Report.—Commended for good workmanship and finish. The instruments are made of domestic woods.

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102. Kirchner Brothers, Vienna, Austria.

CITHERA (ZITHERN).

Report.—Commended for good touch and fine workmanship.

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103. P. Goumas, Paris, France.

WOODEN INSTRUMENTS, AS FLUTES AND CLARIONETS.

Report.—Commended for careful workmanship and powerful tone.

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104. Ahlberg & Ohlson, Stockholm, Sweden.

COLLECTION OF BRASS MUSICAL INSTRUMENTS.

Report.—Commended because the instruments were of good workmanship and yielded a full and rich tone resonant and clear.

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105. Custodio Cardozo Pereira, Oporto, Portugal.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for good workmanship.

---

106. C. Mahillon, Brussels, Belgium.

BRASS AND WOOD MUSICAL INSTRUMENTS.

Report.—Commended for powerful and pure tone, and good workmanship.

---

107. Daniel Fuchs, Vienna, Austria.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for powerful tone, prompt response, and good workmanship.

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108. Joseph F. Farsky, Pardubitz, Austria.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for fine, powerful tone, easy action, and good workmanship.

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109. Bohland & Fuchs, Graslitz, Austria.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for good tone, promptness in action, and fine workmanship.

110. V. F. Cervêny, Königgrätz, Austria.

BRASS MUSICAL INSTRUMENTS FOR BANDS.

Report.—Commended because all the varied instruments presented by this manufacturer were of unexceptionable excellence in workmanship and finish, of rich tone and resonance, with capability of bold or delicate utterance, and were accounted as first-class instruments in all points.

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111. Wilhelm Thie, Vienna, Austria.

MOUTH HARMONICA.

Report.—Commended for good workmanship and cheapness.

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112. Anton Kiendl, Vienna, Austria.

CITHERAS (ZITHERN).

Report.—Commended for good tone and workmanship.

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113. Georg Tiefenbrunner, Munich, Germany.

CITHERAS (ZITHERN).

Report.—Commended for singing, pleasing tone, and good workmanship.

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114. C. A. Müller, Unterwiesenthal, Saxony, Germany.

VIOLIN STRINGS.

Report.—Commended for good quality and workmanship.

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115. Franz Pfaff, Kaiserslautern, Germany.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for powerful pure tone and good workmanship.

---

116. John F. Stratton & Co., Leipsic, Germany.

VIOLINS, WOOD AND BRASS MUSICAL INSTRUMENTS.

Report.—Commended because his productions are of good workmanship and cheap. They are likewise of good quality and yield a good tone to the player.

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117. C. F. Stahlecker, Stuttgart, Germany.

MUSICAL INSTRUMENTS, SUCH AS METALLOPHONES, ETC.

Report.—Commended for cheapness and good workmanship.

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118. Albin Bauer, Jr., Paulus & Schuster, G. A. Pfretzschner, K. A. Glier, Jr., Richard Adler, Ernst Paulus, and August Paulus, Markneukirchen, Saxony, Germany.

COLLECTIVE EXHIBIT OF VIOLINS, GUITARS, ZITHERS, TRUMPETS, FLUTES, AND STRINGS.

Report.—Commended for good workmanship combined with cheapness as articles of trade.

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119. J. Haslwanter, Munich, Germany.

ZITHERS.

Report.—Commended for good finish and strong and fine tone.

120. Morits Glässel, Markneukirchen, Germany.

VIOLINS, VIOLA, AND VIOLONCELLO.

Report.—The quartette of instruments presented possessed excellent qualities in all that is required of such instruments, and were deemed of first-rate make.

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121. A. A. Euler, Frankfort, Germany.

FLUTES AND CLARIONETS.

Report.—Commended for pleasing tone and good workmanship.

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122. C. Bilger, Matth. Hohner, Andreas Koch, and Messner & Co., of Trossingen, and Fr. Holtz, Gottlob Jaeger, and Joshua Jaeger, of Knittlingen, Germany.

COLLECTIVE EXHIBIT OF MOUTH HARMONICAS.

Report.—Commended for good workmanship combined with cheapness as articles of trade.

---

123. F. Besson & Co., London, England.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended because the group comprising all those used in bands, both large and small, contained instruments of the very highest finish in point of workmanship, all of ready manipulation, ease in operating, and of most satisfying purity of tone and richness and far-reaching resonance.

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124. Boosey & Co., London, England.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for power and good quality of tone, and fine workmanship.

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125. A. Lecomte & Co., Paris, France.

BRASS INSTRUMENTS.

Report.—Commended for powerful and pure tone and good workmanship.

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126. Ph. Kompff & Son, New York, N. Y., U. S.

DRUMS, BANJOS, AND TAMBORINES.

Report.—Commended for good finish and workmanship.

---

127. Emmons Hamlin, Boston, Mass., U. S.

FOUR VIOLINS.

Report.—Commended because of superior excellence in workmanship and in tone, the tone bearing a close similarity to that of the "Ole Bull Amati," with which it was compared at the trial by the Committee of the Group.

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128. Boston Musical Instrument Manufactory, Boston, Mass., U. S.

BRASS MUSICAL INSTRUMENTS.

Report.—Commended for strength, finish, and good workmanship.

129. J. Thibouville-Lamy, Paris, France.

BRASS AND STRING INSTRUMENTS, AS VIOLINS AND MECHANICAL PIANOS.

Report.—Commended for good workmanship and cheapness.

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130. Washburn & Moen Manf'g Co., New York, N. Y., U. S.

MUSIC WIRE.

Report.—Commended for fine polish, equal roundness, and good singing quality.

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131. Vanduzen & Tift, Cincinnati, Ohio, U. S.

CHURCH BELLS AND SMALLER BELLS FOR COMMON USE.

Report.—The firm exhibited a variety of bells, from the larger, used for churches and chimes, through all the grades for other and ordinary purposes. They all exhibited skill in casting and in finish. The church bells gave a clear and far-reaching resonance with truth in tones and overtones.

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132. J. F. Stratton, Leipsic, Germany, and New York, N. Y., U. S.

WIND INSTRUMENTS FOR BANDS.

Report.—Commended because they are of good workmanship and form, true in intonation and easy in general management, and are produced at such cheapness in cost as to render them attainable by the largest number of both professionals and amateurs.

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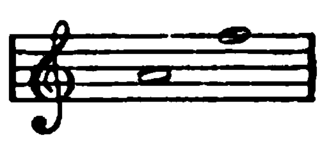
133. Hadank & Son, Hoyerswerda, Germany.

A CHURCH BELL.

Report.—Commended because it shows skill in casting, good general workmanship in the ornaments, a clear and resonant tone, with just harmonics. The key-note is A,  with overtone in F♯. Its weight is about seven hundred pounds, its rim diameter thirty-six inches, and its interior height thirty-one inches.

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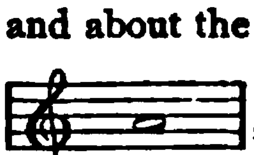
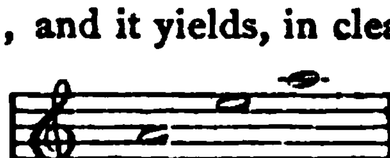
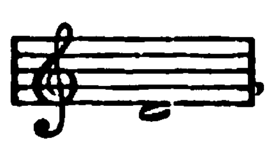
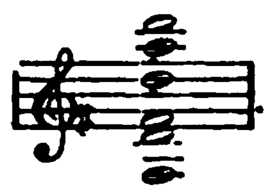
134. De Poli Brothers, Vittorio Veneto, Italy.

A CHURCH BELL.

Report.—Commended because the bell is a work of artistic skill and finish, ingeniously elaborate in design and tasteful in ornament, showing, in relief, figures of Christ on the cross, of St. John the Baptist, St. Paul, St. Peter, St. Lucia, the Virgin Mary and Child, and other delicate ornamental work. The bell is about thirty inches in its rim diameter, and about the same in interior height. The key-note is A, second space of the treble staff, , and it yields, in clear response, the harmonic overtones of the fifth and the octave, thus, . Its weight is about (600) six hundred pounds; the proportion of the metals used being a trade secret. Its tone is surpassingly beautiful, with a clear, resonant ring, the drone lasting (45) forty-five seconds.

135. Wm. Blake & Co., Boston, Mass., U. S.

A FOG BELL.

Report.—Commended for excellence of casting, resonant clearness, and far-reaching power of tone. The bell weighs three thousand and twenty-five pounds, its pitch being D, , with well-defined harmonics, thus: . It is supplied with machinery by which one and two strokes on the bell are given alternately every fifteen seconds.

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136. Gong Bell Manufacturing Co., East Hampton, Conn., U. S.

GONGS AND BELLS FOR HOTELS, HOUSES, AND SLEIGHS.

Report.—Commended because of simplicity of mechanism, quality of material, and good workmanship, with clearness of tone.

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137. Bevin Brothers Manufacturing Co., East Hampton, Conn., U. S.

HOUSE, TABLE, AND SLEIGH BELLS.

Report.—Commended because of admirable workmanship and superior finish, clear and resonant quality of tone, and great variety in their exhibit.

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138. L. Paupier, Paris, France.

SCALES AND BALANCES.

Report.—Manufacturer of the entire range of scale beams and balances, from those used by the druggist and grocer to wagon and railway scales; excellent design and good workmanship, at low prices.

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139. Boston Piston Meter Co., Boston, Mass., U. S.

WATER METER.

Report.—The Boston piston meter is commended for the device by which fractional parts of the piston-stroke are registered, thereby giving an accurate measure whether the full stroke is performed or not.

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140. B. Trayvou, Lyons, Paris, and Marseilles, France.

BALANCES.

Report.—This establishment exhibits a large range of balances and scale beams of various construction, including the most important modern improvements which were originated by the same, such as the jointed bridles, the double beam, and the Beranger scales.

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141. Josef Florenz, Vienna, Austria.

SCALES AND BALANCES.

Report.—Commended for fine workmanship and correct principles of construction.

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142. F. Sartorius, Göttingen, Germany.

ANALYTICAL BALANCES.

Report.—Commended for construction of first-class balances of precision for laboratory and assay use, on the plan of a short beam made of an alloy of aluminium.

143. Frederick Meyer, Newark, N. J., U. S.

WEIGHING SCALES.

Report.—This exhibit consists of hay, coal, and stock scales, portable platform and grocers' counter scales, which are made in a superior manner and possess a certain advantage from use of square knife-edge pivots. The seamless scoop is likewise a valuable improvement.

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144. Buffalo Scale Co., Buffalo, N. Y., U. S.

WEIGHING SCALES.

Report.—A large exhibit of a great variety of weighing scales, iron railway-track and counter scales, of good construction, at low prices, with some original features.

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145. Price, Lipsett, & Co., Philadelphia, Pa., U. S.

WEIGHING SCALES.

Report.—Commended for good construction, with some valuable original devices promoting durability and cheapness.

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146. John C. Dell, Philadelphia, Pa., U. S.

SCALES AND WEIGHTS.

Report.—Gold scales to one hundred pounds, of elegant style and novel design, very sensitive; double-action platform counter scales; and good mode of making common weights.

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147. Henry Troemner, Philadelphia, Pa., U. S.

SCALES AND BALANCES.

Report.—Commended for high perfection in the manufacture of balances for mint and assay purposes, as well as of a great variety of scales for druggists, grocers, and other dealers.

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148. Becker & Sons, New York, N. Y., U. S.

BALANCES OF PRECISION.

Report.—Commended for excellence of design and workmanship, producing great sensibility, permanence of adjustment, and convenience in use, and rendering them almost unrivaled for use in the chemical laboratory and for adjustment of standard weights.

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149. Riehlé Brothers, Philadelphia, Pa., U. S.

WEIGHING AND TESTING MACHINES.

Report.—Commended for the manufacture of railway-track scales, furnace-charging scales, rolling-mill scales, and testing machines for ascertaining the strength of materials, of superior design and construction, combining true mechanical principles with great judgment and ingenuity in the disposition of parts.

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150. Brandon Manufacturing Co., Brandon, Vt., U. S.

WEIGHING SCALES.

Report.—A very extensive exhibit of "Howe" scales, comprising every form and size of scale, from a railroad-track scale to a letter scale, and showing many original adaptations in detail, together with first-rate material and workmanship. The "Howe" platform scales are distinguished from others by the device of chilled iron balls for protecting the pivots' edges from injury while the scale is loading or unloading. This device, while perhaps not superior to some others for the same purposes, is an excellent one, and has earned for the "Howe" scales a deserved reputation.

151. E. & T. Fairbanks & Co., St. Johnsbury, Vt., U. S.

PLATFORM SCALES AND WEIGHING BEAMS.

Report.—Commended for originality in design, excellence of construction, quality of workmanship and materials, accuracy and durability. The exhibit of Fairbanks & Co. comprises a great variety of forms and sizes of scales adapted to every branch of business, such as railway-track, wagon, stock, coal miners', dormant and portable platform, grocers' counter, druggists', and post-office scales, weighmasters' beams and testing scales. The construction of all is excellent in plan and execution, insuring sensibility and endurance.

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152. Henry M. Weaver, Mansfield, Ohio, U. S.

AUTOMATIC GRAVITY PLATFORM SCALE.

Report.—The automatic gravity platform scale is of entirely novel construction, obviates the objection to other automatic gravity scales of great displacement of the article weighed, and is far superior to automatic spring scales, which s on deteriorate. It will prove of great use in shortening the time of weighing in the innumerable dealings of every-day trade.

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153. Seth Thomas Clock Co., Thomaston, Conn., U. S.

TOWER CLOCK AND CLOCKS FOR COMMERCE.

Report.—Commended for a large tower clock, with Denison's double three-legged gravity escapement. The pendulum has a zinc and steel compensation. The weight of the pendulum ball is five hundred pounds; of the rod, two hundred pounds. There is provision against accident from the breaking of the pendulum springs. The driving weight of this clock is two hundred pounds. The whole construction of the train is good, and the action of the escapement is all that can be desired, since an increase in the power applied to the train does not appear to disturb sensibly the arc of vibration of the pendulum. Also for the manufacture of brass clocks in great variety for general use, and of good quality in relation to their prices; and for ornamental clocks.

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154. Hietel Bros. & Geisler, Philadelphia, Pa., U. S.

IMPROVEMENT IN LEVER WATCHES.

Report.—An improvement in the fork of a lever escapement by converting it into a spring bar in a manner such as to prevent the breaking of the roller pin or its excessive rebounding when the balance has received violent motion.

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155. Henry Grandjean & Co., Locle, Switzerland.

CHRONOMETERS AND WATCHES.

Report.—Commended for excellence of workmanship and perfection of the adjustments in the manufacture of marine chronometers; for a collection of fine watches and pocket chronometers, including chronographs, calendar watches, and repeaters, well finished and accompanied with transcripts of the record of their trial at the Observatory of Neuchâtel, officially verified, showing excellence in the several adjustments; and for a simplification of the construction of repeaters, so as to be applicable to smaller sizes than has heretofore been possible. The marine chronometers, of which six were exhibited, were also accompanied with transcripts of the record of their trial in the Observatory at Neuchâtel, showing great perfection in the several adjustments, one of them having maintained its rate during the period of two months of trial with almost the regularity of a well-compensated pendulum clock.

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156. Thomas Mercer, London, England.

MARINE CHRONOMETERS.

Report.—Commended for good workmanship in the manufacture of marine chronometers.

157. E. Paulus, Philadelphia, Pa., U. S.

WATCHES AND CLOCKS.

Report.—Commended for ingenuity in the construction of escapements for watches and clocks.

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158. Louis H. Spellier, Doylestown, Bucks County, Pa., U. S.

CLOCKS.

Report.—Commended for good workmanship in the manufacture of clocks.

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159. B. Haas, Jr., & Co., Paris, France.

WATCHES.

Report.—Commended for a collection of watches of different kinds, and for the decoration of the cases.

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160. Eugène Farcot, Paris, France.

CLOCKS.

Report.—Commended for the variety and excellence of his productions, including alarm clocks and a new and simple system of remontoir for clocks, at moderate prices.

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161. G. W. Linderoth, Stockholm, Sweden.

ASTRONOMICAL CLOCK.

Report.—An astronomical clock, with Graham's escapement and mercurial compensation, of good workmanship throughout.

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162. John Moses Badollet & Co., Geneva, Switzerland.

WATCHES.

Report.—Commended for excellent workmanship in the finish of watch movements of various kinds, including a variety of complicated movements, and for the artistic execution of decorations of watch cases, fine enameling, and exquisitely wrought figures in relief.

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163. H. R. Ekegrén, Geneva, Switzerland.

WATCHES AND POCKET CHRONOMETERS.

Report.—A collection of thirty-six fine watches and pocket chronometers. The whole collection of excellent workmanship, both in regard to the finish of the parts and their proper arrangement in the train. A careful examination of the movements exhibited to us several improvements of construction.

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164. Breting Brothers, Locle, Switzerland.

POCKET CHRONOMETERS.

Report.—Commended for good workmanship in two pocket chronometers.

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165. Louis Frankfeld & Co., Geneva, Switzerland.

WATCHES.

Report.—Commended for excellence in the manufacture of complicated watches, chronographs with independent seconds and minutes, and repeaters, etc., of various sizes.

166. Ernest Francillon & Co., St. Imier, Switzerland.

WATCHES.

Report.—Commended for the production of common watches, partly by machinery, of good quality and of solid construction, at reasonable prices.

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167. Ami Rauss, Geneva, Switzerland.

WATCH DIALS.

Report.—Commended for excellence in the manufacture and decoration of watch dials.

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168. Carl Taglieb, Zurich, Switzerland.

WATCHES.

Report.—Commended for ingenuity and good workmanship in the production of a watch in a finger-ring, upon a plan novel for this purpose.

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169. R. S. Rigtrup, Locle, Switzerland.

IMPROVEMENT IN WATCHES.

Report.—A new mechanism by which a watch, without a fusee, may indicate whether it is wound up or not, and also the number of hours elapsed since it was wound up, which is ingenious and efficacious.

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170. Patek, Phillippe, & Co., Geneva, Switzerland.

WATCHES AND PARTS OF WATCHES.

Report.—A collection of watches and parts of watch movements. The collection contains complicated watches of all kinds, chronographs single and double, repeaters, and calendar watches, etc. Those with independent seconds are constructed upon a new system worthy of commendation.

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171. Jacot Brothers, Locle, Switzerland.

WATCHES AND POCKET CHRONOMETERS.

Report.—Eight complicated watches, chronographs, and repeaters of different kinds, and one pocket chronometer, all of good workmanship, and all of which had been subjected to the proper trials in the Observatory at Neuchâtel, and were accompanied with transcripts of the records of the trials, officially verified, showing good adjustments.

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172. Charles Jeanjaquet, Neuchâtel, Switzerland.

MAINSPRINGS FOR WATCHES AND STEEL FOR LITHOGRAPHIC PENS.

Report.—Commended for the manufacture of steel ribbon for lithographic pens of good quality, and for excellence in the manufacture of springs for watches.

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173. A. Huguenin & Sons, Locle, Switzerland.

WATCHES AND CLOCK ESCAPEMENTS.

Report.—Commended for good workmanship shown in a collection of watches, simple and complicated, and for escapements for fine clocks.

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174. P. F. Ingold, Chaux-de-Fonds, Switzerland.

FRAISES OR CUTTERS FOR WHEELS OF WATCHES.

Report.—Commended for the invention and production of fraises or cutters to give the epicycloidal form to the teeth of the wheels of watches.

175. David Perret Son, Neuchâtel, Switzerland.

WATCHES.

Report.—Commended for the production of good common watches with lever escapements, by the use of machinery in their construction, at exceedingly low prices.

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176. Aimé Perrenoud, Geneva, Switzerland.

BALANCE SPRINGS FOR WATCHES.

Report.—Commended for the manufacture of steel and gold balance springs for watches, in form flat, spherical, or cylindrical, the qualities of which are great elasticity and toughness, evenness of gauge, and correctness of winding.

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177. C. Montandon, Gentil-Lütz, Geneva, Switzerland.

BALANCE SPRINGS FOR WATCHES.

Report.—Commended for the manufacture of flat and cylindrical balance springs for watches, which bore admirably tests for evenness of gauge, for elasticity, and for other desirable qualities.

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178. James Nardin, Locle, Switzerland.

WATCHES AND POCKET CHRONOMETERS.

Report.—A collection of complicated watches, including chronographs and repeaters of all kinds, independent seconds, etc., and a pocket chronometer, all of which are of excellent workmanship and well sprung. The records of their performance, as determined by the maker showed that the adjustments are good.

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179. Charles Martin & Co., Geneva, Switzerland.

WATCHES.

Report.—A varied assortment of watches embracing a good line of commercial goods in respect to movements and decoration of cases.

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180. Charles H. Meylan, Solliat, Vaud, Switzerland.

IMPROVEMENT IN CHRONOGRAPH WATCHES.

Report.—Commended for improvement and simplification of the mechanism in chronograph watches, both single and minute, by which the cost of manufacture is greatly reduced.

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181. A. Hahl & Co., Baltimore, Md., U. S.

ELECTRIC CLOCKS, BELLS, INDICATORS, BURGLAR ALARMS, AND TOWER CLOCKS.

Report.—By a very well designed electric connection, a tower clock, however large, is regulated by a pendulum having the delicacy and accuracy of the pendulum of an astronomical clock. The pendulum itself is actuated by a movement analogous to the marine chronometer escapement of Harrison, but altogether novel in its application to a seconds pendulum. I believe that the performance of this escapement will be much superior in accuracy to that of the best dead-beat escapement of the astronomical clock. The apparatus is of a thoroughly practical character, hardy and durable, as well as delicate and pure in scientific principle. I believe it to be an important improvement in horology. Sympathetic electric clocks, bells and annunciators, burglar alarms, seem good also. The electric action for the sympathetic clocks is (as in Hipp's successful European system) by a short current every minute alternately in opposite directions.

182. H. Ls. Matile, Locle, Switzerland.

POCKET CHRONOMETERS AND WATCHES.

Report.—Five complicated watches, single and double chronograph, minute repeaters and calendar, etc., and one pocket chronometer, all of excellent workmanship, and accompanied with transcripts, officially verified, of the record of their trial at the Observatory at Neuchâtel, showing that their adjustments were good.

183. Aubert Brothers, Savagnier, Switzerland.

MAINSPRINGS FOR WATCHES.

Report.—Commended for the manufacture, at low prices, of mainsprings for watches, which are of good quality, being strong and elastic.

184. Borel & Courvoisier, Neuchâtel, Switzerland.

WATCHES AND POCKET CHRONOMETERS.

Report.—Commended for excellence of workmanship in the manufacture of watches and pocket chronometers, of which five were accompanied by the transcript of the record of their trial at the Observatory at Neuchâtel, officially verified, showing that the adjustments are good.

185. Louis Audemars, Brassus, Vaud, Switzerland.

WATCHES AND POCKET CHRONOMETERS.

Report.—Commended for excellence in the manufacture of watches, both simple and complicated, and for pocket chronometers.

186. Edward Berlie, Geneva, Switzerland.

WATCH SPRINGS.

Report.—Commended for excellence of workmanship in the production of steel springs for watches and of steel ribbon for lithographic pens.

187. Baehni Brothers, Bienne, Switzerland.

STEEL AND GOLD BALANCE SPRINGS FOR WATCHES.

Report.—Commended for the good quality and variety of manufacture of steel and gold balance springs for watches.

188. J. B. Bitterlin-Schmidt, Locle, Switzerland.

JEWELS FOR WATCHES.

Report.—Commended for excellence in the production of finished precious stones and jewels for watchmaking.

189. Eug. Besancet-Blanc, Travers, Neuchâtel, Switzerland.

COLLECTION OF FINISHED WATCH JEWELS AND PARTS OF ESCAPEMENTS.

Report.—Commended for great excellence in the production of finished jewels for watches, for ruby pinions, for a ruby cylinder escapement, for ruby rollers and pallets, for chronometer escapements, all attesting the highest skill.

190. J. Corcelle & Co., Geneva, Switzerland.

WATCH DIALS.

Report.—Commended for excellence in the manufacture and decoration of watch dials.

191. E. Klein, Geneva, Switzerland.

MAINSPRINGS FOR WATCHES.

Report.—Commended for excellence in the manufacture of mainsprings for watches.

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192. Hangard, Paris, France.

WATCH, CLOCK, AND CHRONOMETER SPRINGS.

Report.—Commended for excellence in the manufacture of springs for watches, clocks, and chronometers.

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193. E. Rosset, Paris, France.

MYSTERIOUS CLOCKS.

Report.—Commended for good execution in the manufacture of mysterious clocks.

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194. Collective Exhibit of Schwarzwald Clocks, viz.: 1. Clock Mfg. Co., Lenzkirch. 2. Bened. Schwer, Jr., Tryberg. 3. Ph. Haas & Sons, St. Georgen. 4. Em. Wehrle & Co., Furtwangen. 5. Leo Kaltenbach, Furtwangen. 6. B. Ketterer Sons, Furtwangen. 7. Lorenz Bob, Furtwangen. 8. Maurer & Hoefler, Eisenbach. 9. J. Bapt. Beha & Sons, Eisenbach, Germany.

CLOCKS.

Report.—These manufacturers, acting conjointly, exhibit a large collection of clocks in great variety of sizes and finish. The movements are well finished for the particular grades of clocks exhibited, which are principally of the grade of clocks known as "Schwarzwälder Uhren." Among them are regulators with well-finished trains and escapements, but with wooden pendulums, made by L. Kaltenbach, L. Bob, and B. Ketterer Sons; also regulator clocks with well-finished movements and compensation pendulums, by Maurer & Hoefler and the Clock Mfg. Co. The exhibit contains also three trumpet clocks, by Em. Wehrle & Co., worthy of special mention. There are in the exhibit a large number of what are called *cuckoo clocks*, with elaborately-carved cases. Commended for variety in construction and excellence of workmanship in relation to the prices charged, and for the exhibits specially mentioned.

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195. M. Hipp, Neuchâtel, Switzerland.

ELECTRIC CLOCK, REGULATOR, AND SYMPATHETIC CLOCKS.

Report.—In the electric clock exhibited, a most ingenious mechanical appliance of a very simple and effective character makes an electric contact whenever the range of the pendulum falls short of a certain limit, and thus gives a fresh impulse to the movement by aid of a voltaic cell. The wheel-work which counts the vibrations of the pendulum is driven by it, and so the clock is kept going without winding up a weight. Mr. Hipp's system of regulator with sympathetic clocks is used with much success in many cities of Europe. A fine pendulum, like that of an astronomical clock, with dead-beat escapement urged by a uniform force through an ingenious kind of remontoir mechanism, controls a powerful clock driven by a heavy-enough weight. This clock makes electric contacts by which any number of distant electric clocks (in all parts of a town, for instance) are kept going in perfect sympathy with it. For any one of these clocks a current is sent through the wire (the clock-telegraph wire of the town or district) to it once every minute, and is kept flowing during about half a second. These currents are sent in reverse directions in the alternate minutes. A magnetized steel armature is thus moved, by an electro-magnet, through a safe angle of about 60° by every current alternately in opposite directions, and moves the clockwork for-

ward a minute each time. Mr. Hipp justly claims for this system great immunity—practically perfect immunity, I believe I may say—from disturbance by lightning discharges. A discharge along the wire in one direction would not move the armature; in the opposite direction would only anticipate the effect of the regulator's current coming at the end of the minute. Alternate currents in opposite directions within a minute, which could set the clock fast by a minute or more, are so rare a result of atmospheric electricity as not to constitute any practical embarrassment to Mr. Hipp's system.

196. Hadank & Son, Hoyerswerda, Germany.

TURRET CLOCK AND BELL.

Report.—A turret clock and bell, the former of good construction both in the train and in the escapement, and the latter of excellent composition.

197. A. Lange & Sons, Glashütte, Saxony.

WATCHES.

Report.—Commended for excellent workmanship in the construction and adjustment of watch movements, and for an ingenious and effective modification of the lever escapement.

198. G. Becker, Freiburg, Silesia, Germany.

CLOCKS.

Report.—Commended for excellence of workmanship in the manufacture of astronomical clocks with zinc and steel compensation, and also for the variety and good quality of the clocks and parts of clocks, of uniform sizes (so as to be interchangeable in the movements), exhibited and manufactured by him.

199. Bontems, Paris, France.

CLOCKS WITH SINGING BIRDS AND CAGES WITH SINGING BIRDS.

Report.—Commended for good execution in the manufacture of ornamental clocks with artificial singing birds, and for artificial singing birds.

200. Eugène Moat, Revigny, France.

WATCH SPRINGS.

Report.—Commended for the production of a good quality of watch springs at moderate prices.

201. Mayet-Tissot, Morez, France.

REGULATOR AND CALENDAR CLOCKS.

Report.—Commended for the skill and excellent workmanship shown in a large regulator and calendar clock, and for good workmanship in the construction of a regulator with second and pendulum and mercurial compensation.

202. John Bliss & Co., New York, N. Y., U. S.

MARINE CHRONOMETERS AND PORTABLE TRANSITS.

Report.—Commended for excellence of workmanship in the manufacture and adjustment of all the parts of the movements of marine chronometers, and for great skill in the adjustment of marine chronometers for both temperature and isochronism, as shown by thorough

tests made by us for four of their chronometers. Also for portable and convenient astronomical transits for the use of watchmakers and others desiring a correct knowledge of the mean solar time.

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203. A. H. Rodanet, Paris, France.

MARINE CHRONOMETERS.

Report.—Commended for excellence of workmanship in the manufacture of marine chronometers, and for skill in the adjustment of the same for temperature.

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204. A. Hohwü, Amsterdam, Netherlands.

ASTRONOMICAL CLOCKS.

Report.—Commended for excellence of workmanship in the manufacture of astronomical clocks.

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205. American Watch Co., Waltham, Mass., U. S.

WATCHES.

Report.—The movements made by this company are constructed upon what is known as the "American system," with interchangeability of parts for the several grades manufactured, and by the use of machinery devised and perfected in their factory, and by them first brought into use for the purposes of watchmaking. There can be no doubt that the application of machinery, to a great extent automatic, constructed so as to act upon scientific principles, must result in the production of the parts of watch movements with precision and uniformity. This superiority will always be the more marked in the ordinary and medium grades of movements as to price, so that this company is enabled to produce in the case of such movements better watches than are produced by the other methods in use. We have examined a large number of watch movements of these grades with plain or compensated balances, which had uniformly good trains and were well sprung, so that their timekeeping properties must be of the highest order for watches not specially adjusted. We have also examined the operation of the machinery for the production of the parts, and the instruments used in springing the watches and for other adjustments, and we have been convinced of the certainty of the processes which they employ, and we consider them justly entitled to special commendation.

This company also exhibited watches, the parts of which were made by machinery and highly finished, and which had been adjusted for isochronism, for position of the balance, and for temperature. Since these watches had not been subjected to trials in an astronomical observatory, and the requisite astronomical instruments were in position and available at the United States Government Building, we asked for and received ten movements from the exhibit to be submitted to the requisite tests.

These tests were as follows:

1st. For temperature, forty-eight hours in the refrigerator and forty-eight hours in a heated room.

2d. For errors of position and isochronism the tests were during a period of ten days.

The results showed the excellence of the several adjustments, the small errors outstanding being far within the limits considered as the proper standard of excellence in the adjustment of first-class pocket chronometers. All of the watches made by the American Watch Co. are provided with Fogg's safety pinion, invented in 1865, which obviates the possibility of injury to the movement from the breaking of the mainspring, which is an improvement.

OBSERVATORY, ANN ARBOR, MICH., Sept. 5, 1876.

To the United States Centennial Commission,

International Exhibition, Philadelphia.

In explanation of the latter part of the report for an award to the American Watch Co., I desire to submit in the subjoined table the summary of the results which I obtained in the trial of their adjusted watches at Philadelphia. It is only in Switzerland that tests of adjusted pocket chronometers are regularly made at Observatories, and for the information of the manufacturers in regard to the qualities of their productions; and heretofore the best pocket chronometers have been made in that country. In order to show the comparison complete, hereafter, in my report upon Horology at the International Exhibition at Philadelphia, I have in progress at this Observatory a further trial of the same movements in the completest form possible, both for the adjustments already tested, and for the steadiness of the rate of each for a considerable period of time. The facts stated in a report for an award were thoroughly established in the trials which we made at Philadelphia, that for temperature having been much more severe than is made in Switzerland, the watches having been placed first forty-eight hours in a refrigerator and then forty-eight hours in a heated room. The separate results are as follows:

No. of the movement.	Variation in 24 hours for ± 1° of temperature.	Difference in 24 hours between hanging and lying.	Maximum error of position in 24 hours.
	s.	*s.*	*s.*
670,075	± 0.034	...	...
670,099	± 0.188	...	...
670,095	± 0.024	...	...
670,061	± 0.014	2.5	1.4
670,087	± 0.038	0.4	8.3
670,083	± 0.012	0.2	0.5
670,052	± 0.064	1.3	6.7
670,044	± 0.052	0.6	1.4
670,082	± 0.064	0.1	0.8
670,092	± 0.240	0.4	7.0
The mean of all gives			
	s.	*s.*	*s.*
	± 0.07	1.07	3.7

The first three movements named above were tested only for temperature.

Without making a comparison with any particular manufacturer, it is proper to state here the mean results from a large number of first-class pocket chronometers submitted to trial at the Observatory in Neuchâtel in the years 1873, 1874, and 1875 respectively. The results published by the director of the Observatory, Dr. Hirsch, are as follows:

Year.	Variation in 24 hours for 1° of temperature.	Difference in 24 hours between hanging and lying.
	s.	*s.*
1873	± 0.15	2.59
1874	± 0.15	2.27
1875	± 0.13	1.97

The trials at the Swiss Observatories extend over a period of time sufficient to determine the mean variation of the daily rate.

The limited time of my residence in Philadelphia did not permit me to make this test prior to the report for awards; but, as already stated, I will complete and publish the results for this test also in a subsequent report to you upon the Exhibition in the department of Horology.

All of which is respectfully submitted. JAMES C. WATSON,

Director of the Observatory, etc.

Judge in Group XXV., International Exhibition.

206. James Poole & Son, London, England.

CHRONOMETERS AND WATCHES.

Report.—Commended for excellence of workmanship in the manufacture of marine and pocket chronometers. Two of the marine chronometers exhibited were tested by us for the adjustment of the balance for compensation for temperature, and for the rate before and after the extremes of temperature, and the adjustments were found to be excellent.

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207. A. de Casseres, Amsterdam, Netherlands.

MARINE CHRONOMETERS.

Report.—Commended for good workmanship in the manufacture and adjustment of marine chronometers.

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208. M. F. Dent, London, England.

CHRONOMETERS AND CLOCKS.

Report.—Commended for excellence of workmanship in the manufacture of marine and pocket chronometers, and of clocks with chronometer and lever escapements; also for fine small two-day chronometers in pocket case, for exploring parties or for field use, with effective provision against overbanking.

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209. Nicole, Nielsen, & Co., London, England.

WATCHES.

Report.—Commended for excellence of workmanship in the manufacture of pocket chronometers, and sporting, calendar, and repeating watches, and for an improved system in the construction of stem-winding watches.

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210. Charles Frodsham & Co., London, England.

CHRONOMETERS, CLOCKS, AND WATCHES.

Report.—Commended for excellence of workmanship in the manufacture of marine chronometers, watches, and clocks; for highly-finished astronomical clocks, and for a collection of compensated chronometer balances of a variety of forms for simple and auxiliary compensation. The marine and surveying chronometers were all of excellent finish, and appeared to be well sprung.

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211. V. Kuhlberg, London, England.

CHRONOMETERS AND WATCHES.

Report.—Commended for excellence of workmanship in the manufacture of marine and pocket chronometers.

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212. J. Sewell, Liverpool, England.

CHRONOMETERS AND WATCHES.

Report.—Commended for good workmanship in the manufacture of pocket chronometers and watches, and for the production of good marine chronometers with simple compensation, at very moderate prices.

213. Silas Fournier, New Orleans, La., U. S.

TELLTALE AND STARTERS' CLOCKS.

Report.—Commended for ingenuity and excellence of workmanship in the construction of clocks which perform the function of sounding the instants of starting cars from a station upon three different lines, if desired, at fixed intervals, and of indicating the presence of watchmen at appointed hours.

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214. John L. Gropengiesser, Philadelphia, Pa., U. S.

ASTRONOMICAL CLOCK.

Report.—An astronomical clock, with mercurial compensation, well finished throughout.

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215. Charles Fasoldt, Albany, N. Y., U. S.

ASTRONOMICAL TOWER CLOCK.

Report.—Commended for a new form of gravity escapement for clocks, which performs with precision and avoids error from tripping; for the adaptation of a fine clock with compensated pendulum to the office of controlling directly the movement of a tower clock in connection; for skill in adjusting the action of the pendulum springs so as to secure isochronous vibrations in the case of different arcs within reasonable limits; and for the mechanism by which the turret clock is securely driven by relatively small weights.

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216. Ithaca Calendar Clock Co., Ithaca, N. Y., U. S.

CALENDAR CLOCKS.

Report.—Commended for the production of good calendar clocks, tested for running accuracy of perpetual calendar for a period of eight years, and at moderate prices.

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217. Ansonia Brass and Copper Co., New York, N. Y., U. S.

CLOCKS.

Report.—Good clocks, in great variety, for commerce, the movements of brass and of brass nickel-plated.

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218. Province of Rio Grande do Sul, Brazil.

METAL MERIDIAN.

Report.—Commended for ingenious and artistic design and elegant construction of an instrument for indicating automatically the instant of noon.

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219. Captain Luiz Philippe de Saldanha da Gama, Brazilian Navy, Brazil.

NAUTICAL REPEATING COMPASS.

Report.—Commended for the design and construction of a nautical azimuth compass, with repeating movement, giving the means of increased accuracy of results.

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220. B. F. Greene, Navy Department, Washington, D. C., U. S.

APPARATUS FOR CORRECTING SHIPS' COMPASSES.

Report.—The apparatus exhibited supplies a complete solution of the problem of the correction of compasses on iron ships. The apparatus for testing the accuracy of the compass also possesses great merit, and its use has contributed much to the improvement of the compass at present in use in the United States Navy.

221. E. S. Ritchie & Sons, Boston, Mass., U. S.

PROF. C. S. LYMAN'S DEEP-SEA WAVE MACHINE.

Report.—It is a beautiful and most instructive mechanical representation of the motion of water in a deep-sea wave.

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222. Prof. F. L. Ekman, Stockholm, Sweden.

APPARATUS FOR SCIENTIFIC EXPLORATION OF THE OCEAN.

Report.—Commended for a novel and ingenious apparatus for observing the temperature and density of sea-water at great depths, and for portable evaporiments all designed and well adapted for scientific explorations of the ocean.

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223. John Bliss & Co., New York, N. Y., U. S.

TAFFRAIL LOG.

Report.—An improved construction of Munk & Myrhe's taffrail log, by which the registering train is not subjected to the jerks of the towing-line, and the instrument therefore made more durable and correct in its indications.

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224. Riggs & Brother, Philadelphia, Pa., U. S.

TAFFRAIL LOG.

Report.—An improved construction of Munk & Myrhe's taffrail log, by which the registering train is made independent of the varying strains and jerks of the line, and therefore more durable and correct in its indications.

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225. Astronomical Observatory of San Fernando, Cadiz, Spain.

INSTRUMENTS FOR SURVEYING AND NAVIGATION.

Report.—Commended for excellent workmanship and some novelties of design in instruments for surveying and navigation, constructed at the establishment, for use in the Spanish Navy.

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226. Dr. Martin Wiberg, Stockholm, Sweden.

DEEP-SEA DRAG AND LOGARITHM TABLES.

Report.—Exhibits logarithmic tables, calculated and printed by calculating machine of his invention, by which means the results are free from errors; also a deep-sea drag, of excellent design, for exploration of the sea-bottom.

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227. F. Wedel-Jarlsberg, Christiania, Norway.

SHIP'S LOG.

Report.—The log invented by this officer of the Norwegian Navy gives a constant indication of the speed of a vessel by means of the ordinary log-board acting upon a spring through a cord. It is doubtless a great improvement upon the old log-line and hourglass.

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228. Dr. Josua Lindahl, Lund, Sweden.

APPARATUS FOR DEEP-SEA EXPLORATIONS.

Report.—Dr. Lindahl exhibits a series of ingenious contrivances, of his invention, for the scientific exploration of the ocean, such as dredges, sieves, scoops, towing-nets, and appropriate vessels of copper and glass.

229. J. W. L. Gundberg, Stockholm, Sweden.

VESSELS AND APPARATUS FOR PRESERVING ANIMALS.

Report.—Exhibits a collection of iron vessels and apparatus constructed with very practical adaptation for the preservation of animals collected in maritime explorations.

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230. E. S. Ritchie & Sons, Boston, Mass., U. S.

RITCHIE'S FLOATING COMPASS.

Report.—1. Shortness of period and quick extinction of free oscillations have been generally believed to be valuable qualities for a marine compass, and have been made primary objects in nearly all attempts to improve the instrument. They are attained to a remarkably high degree in Ritchie's floating compass.

2. This compass has, to a superlative degree, the truly valuable quality of freedom from frictional error. I have severely tested it in respect to this quality, and have failed to get it held by friction at as much as $\pm .1^\circ$ from its correct position.

3. The manner in which No. 2 is obtained (being buoyancy of the compass-card, which leaves only from $\frac{1}{100}$ to $\frac{1}{40}$ of the weight to be supported on the bearing point, according to the temperature, if from 13° to 85° Fahr.) secures that the wear by the continual motion at sea shall be very slight, and fairly promises that after many years of sea-service the good quality No. 2, if impaired at all sensibly, will still be practically perfect without resharpening of the bearing point.

4. Clearness and accuracy of divisions and accurate centering in the perfected form of Mr. Ritchie's instrument used in the United States Navy. These qualities, together with No. 2, render this truly an instrument of precision.

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231. E. S. Ritchie & Sons, Boston, Mass., U. S.

MARINE AZIMUTH COMPASS.

Report.—By proper reflecting surfaces the line of vision is brought to such a direction that the observer looks downward towards the compass-bowl in taking azimuth or bearings by this instrument. Thus is secured the great advantage of permitting the application of the masses of soft iron required to correct the quadrantal error of the compass in an iron ship without impeding the use of the instrument for taking azimuth of celestial and terrestrial objects in any direction. The subordinate but still considerable practical advantage of seeing the degree-numbers on the compass-card direct, instead of inverted as in the ordinary prism-compass, is obtained by a second reflection in Mr. Ritchie's azimuth compass.

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232. Rudolph Koenig, Paris, France.

ACOUSTIC APPARATUS.

Report.—In the construction of apparatus of precision for purposes of research or demonstration in acoustics, the very ingenious optical methods for the analysis of musical sounds by means of manometric flames were devised by Dr. Koenig in 1862, and have since been greatly improved by him and applied also to the study of the phenomena of interference. More recently he has made a very elaborate investigation of the nature and causes of the resultant sounds heard when two notes of different pitch are sounded together, and has shown that even very eminent investigators have been in error in their views of these phenomena.

In the present exhibition Dr. Koenig has presented a collection of instruments of demonstration and investigation constructed on a scale of magnitude heretofore unattempted, and exhibiting with surprising power the effects of interfering undulations.

He also presents a tonometric apparatus, consisting of about six hundred and seventy

diapasons, or tuning-forks, giving as many different shades of pitch extending over four complete octaves, and making equal intervals of eight simple vibrations each for the first octave, and of twelve each for the succeeding octaves; the whole forming an absolutely perfect means of testing, by count of beats, the number of vibrations producing any given musical sound, and of accurately tuning any musical instrument.

In addition to these more conspicuous portions of his display, Dr. Koenig exhibits the various forms of apparatus of demonstration for which he is so well known, all of which are marked by the accuracy of indications and excellence of workmanship which have given him his deserved reputation as a constructor. One instrument of novel character, not yet fully completed, and exhibited only as an untested project, promises too interesting results to be overlooked in this report. It is a multiple sirène, designed to produce synthetically the various qualities of musical sound by the combination of overtones with the fundamental, and also to exhibit the effects of varying phase in the formation of such combinations. Of the exhibit of Dr. Koenig, as a whole, it may be said that there is no other in the present International Exhibition which surpasses it in scientific interest.

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233. N. H. Edgerton, Philadelphia, Pa., U. S.

POLARISCOPE FOR EXACT INVESTIGATION; STEREOPTICON WITH SELF-CONDENSING GAS CYLINDERS.

Report.—The polariscope is a neat and compact instrument, with black mirror polarizer and Nicol analyzer, provided with co-ordinate graduated circles for the object, and a graduated azimuth circle for the analyzer. It is recommended by its convenience and cheapness.

The stereopticon may be used for either horizontal or vertical projection. It is well made, and has some peculiarities of mechanical contrivance which appear to be advantageous.

By the term self-condensing gas cylinders the exhibitor intends cylinders so constructed that the materials for generating oxygen and hydrogen may be introduced into them directly, so that they are made to serve as generators as well as for reservoirs.

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234. N. H. Edgerton, Philadelphia, Pa., U. S.

PHILOSOPHICAL INSTRUMENTS.

Report.—Commended for excellence of design and workmanship in a large variety of scientific apparatus for illustrations in teaching, and for research. I note particularly an inductive electrical machine with vulcanite disc and inductor kept electrified by friction; a large, finely-poised Ampère's solenoid, well adapted for lecture illustrations; an apparatus for optical projection of a very complete character, well adapted for lecture illustrations; a polariscope for "subjective" use; and a very good direct-vision spectroscope.

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235. Western Electric Manufacturing Co., Chicago, Ill., U. S.

GALVANOMETERS AND RESISTANCE COILS.

Report.—Commended for excellence of workmanship.

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236. Jacob Diamond, Pittsburg, Pa., U. S.

PEBBLE LENSES FOR SPECTACLES AND EYE-GLASSES.

Report.—Commended for good workmanship and clear material. Pebble lenses are greatly superior to those of glass, when, as in spectacles, frequent rubbing is necessary, on account of their hardness.

237. James Prentice, New York, N. Y., U. S.

SURVEYING AND LEVELING INSTRUMENTS.

Report.—Surveying and leveling instruments carefully manufactured.

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238. Sécretan, Paris, France.

ASTRONOMICAL TELESCOPES.

Report.—Commended for excellence in the manufacture of achromatic telescopes and reflecting telescopes with silvered mirrors upon Foucault's plan.

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239. Jean Adrien Deleuil, Paris, France.

INSTRUMENTS OF PRECISION AND RESEARCH.

Report.—The instruments exhibited by Mr. Deleuil as specimens of his manufacture are the following: 1. A vacuum-balance for the adjustment of standard weights not exceeding one kilogramme. 2. A collection of balances of precision ranging from a capacity of 200 grammes in each pan to that of 5 kilogrammes, the accuracy of which leaves nothing to be desired. 3. Balances for weighing gold and silver ingots, and for the delivery of gold coin. 4. An automatic assorting apparatus for the use of mints, by which gold coin is divided into three classes, viz., light, exact, and heavy. 5. Chemical laboratory scales with special conveniences for weighing balloons and long-necked bottles. 6. A photometer according to the plan of Dumas and Regnault. 7. A receiver for testing the purity of gas by means of a prepared acetate of lead paper. 8. A collection of standard weights and measures. 9. Two air-pumps of new construction with frictionless pistons, which may be used either as exhausters or condensers. All the instruments and apparatus above mentioned are constructed with the greatest degree of perfection.

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240. John Byrne, M.D., Brooklyn, N. Y., U. S.

GALVANIC BATTERY.

Report.—A platinum wire of considerable length and diameter is brought to white heat by this battery, though its surface is but small, and though the liquid employed is but the common mixture of bichromate of potassium and sulphuric acid. This effect is produced by the action of an improved agitator which, driving a stream of small air-bubbles through the liquid, removes the products of polarization from the metallic surfaces.

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241. Prof. Dmitri Mendeleief, St. Petersburg, Russia.

DIFFERENTIAL BAROMETER.

Report.—The instrument exhibited is one of great ingenuity and usefulness, giving, by difference of atmospheric pressure, the difference of elevation with great precision, to a difference of about three hundred and twenty feet, when the equilibrium is re-established in the simplest manner, and a new departure taken. An important addition to orographical surveying.

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242. Theodore Ezersky, St. Petersburg, Russia.

COMPUTING APPARATUS.

Report.—A computing instrument, which combines with a table of products an abacus, by which means multiplications may be performed with great ease without writing the figures.

243. Jacob Pick, Warsaw, Russia.

PHILOSOPHICAL INSTRUMENTS.

Report.—The exhibitor manufactures philosophical instruments for instruction in physical science, of good quality, and merits encouragement.

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244. Wladimir Martiooshef, St. Petersburg, Russia.

TELEMETRIC APPARATUS.

Report.—Colonel Martiooshef exhibits a telemetric apparatus for military purposes, consisting of two pairs of cross-telescopes placed at opposite ends of a short measured base-line, one telescope being directed to the distant object, while the other, placed at right angles, reads off the distance on a scale attached to the fellow-instrument at the other end of the base. A very well designed and carefully constructed apparatus.

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245. B. A. Gould, Cordoba, Argentine Republic.

PHOTOGRAPHS OF STARS IN THE SOUTHERN HEMISPHERE.

Report.—The photographs of star-clusters exhibited by Dr. Gould are remarkable for showing with good definition, suitable for micrometric measurement, stars as faint as the ninth magnitude. The long exposure required for such images demands the greatest care and precautions to insure the uniform rate of clock-work and proper condition of collodion. Dr. Gould has thus extended to stars of small magnitudes this admirable method of determining their relative positions, first developed by Mr. L. M. Rutherfurd.

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246. H. J. Harting Bank, Utrecht, Netherlands.

PHILOSOPHICAL APPARATUS.

Report.—The collection of apparatus designed for instruction in science, manufactured by Mr. Harting Bank under the auspices of the Society of Teachers in Holland, is more remarkable for its low price than its perfection; but it deserves recognition on account of the proposed object of placing within the reach of primary instruction apparatus necessary for elementary science teaching.

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247. Wallace & Sons, Ansonia, Conn., U. S.

REGULATOR FOR ELECTRIC LIGHT.

Report.—This regulator, which was exhibited in connection with Mr. Farmer's magneto-electric machine, is of particularly simple construction, having no wheel-work. It seemed to work very well.

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248. Hermann & Pfister, Berne, Switzerland.

PHILOSOPHICAL INSTRUMENTS.

Report.—This firm exhibits a "Wild's Polaristrobometer" or saccharometer, and an improved hair hygrometer, of excellent construction.

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249. L. G. Perreaux, Paris, France.

MEASURING INSTRUMENTS.

Report.—Commended for good manufacture of measuring instruments, such as dividing machines, micrometer screws, and dynamometers.

250. J. P. Ljungström, Stockholm, Sweden.

PLANIMETER.

Report.—It is an improved polar planimeter for measuring areas, which possesses special advantages over others in cases where the area is very oblong. Moreover, it is of excellent workmanship.

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251. A. J. Theorell & P. Sörensen, Stockholm, Sweden.

SELF-REGISTERING METEOROLOGICAL APPARATUS.

Report.—An admirable machine which registers automatically, at every quarter-hour, the force and direction of the wind, the temperature of the dry and of the moist thermometer, and the height of the barometer, the indications being printed in figures in regular columns. Moreover, it is of excellent workmanship.

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252. Dr. Franz Paugger, Trieste, Austria.

DROMOSCOPE.

Report.—The "Dromoscope" of Dr. Paugger is an ingenious and exact machine for calculating the required compass-courses from true courses, and *vice versa*, when the usual co-efficients for the disturbance of a compass on an iron ship have been determined in the customary way. While there are other methods, partly graphical, partly mechanical, in which the same result is obtained, the "Dromoscope," by its simple and unerring operation, fills a want that is felt by many navigators to whom the other methods are onerous and obscure, and it cannot fail to prove of great advantage to navigation. On ships of war, where the graphical methods are well understood, the "Dromoscope" will still serve an important purpose as a check against error. We believe the instrument to be of practical value to navigation and highly ingenious in its conception.

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253. Pulvermacher Galvanic Co. for Medical Purposes, Cincinnati, Ohio, U. S.

GALVANIC CHAINS, BELTS, AND BANDS.

Report.—The apparatus is portable, and can be easily applied to any parts of the body through which a continuous current of galvanism is to be transmitted. The circuit will continue as long as any moisture of weak acid remains in the insulating material between the links of the chain. An arrangement for giving shocks is produced by uniting two chains so as to make one of double length,—the union being produced by a spiral spring in a glass tube joining the two ends of the two chains in metallic contact when the apparatus is shaken; thus a series of shocks is produced, the intensity of which depends on the length of the chains.

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254. J. J. Hicks, London, England.

METEOROLOGICAL INSTRUMENTS.

Report.—This exhibition consists of a very large collection of meteorological instruments, such as barometers and thermometers of all kinds; anemometers for self-recording and direct observations. These instruments are of the newest construction and well made.

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255. Ministry of Finance, The Hague, Netherlands.

SCIENTIFIC INSTRUMENTS AND TABLES.

Report.—Commended for accuracy and convenience of instruments and tables for determining the value of spirituous liquors.

256. Van Wetteren Brothers, Haarlem, Netherlands.

MAGNETS.

Report.—Commended for the manufacture, under the direction of Prof. Van der Willigen, of powerful magnets composed of thin laminæ.

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257. Giuseppe Tagliabue, New York, N. Y., U. S.

SELF-REGISTERING METEOROLOGICAL INSTRUMENTS, HYDROMETERS, AND MILK TESTER.

Report.—Commended for the careful construction of Draper's self-recording barometer, thermometer, and rain gauge; the accurate manufacture of the spirit hydrometers adopted by the United States Government; and the invention and construction of a milk tester, the indications of which do not depend upon the gravity of the liquid, but on the amount of milk solids, which, by a simple operation, are separated and measured with a sufficient degree of accuracy to be of practical value.

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258. Martinho da França Pereira Coutinho, Lisbon, Portugal.

MATHEMATICAL INSTRUMENTS.

Report.—The pyramidal compasses for reduction, and the goniometric and telemetric compass, are of novel and useful design.

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259. Negretti & Zambra, Holborn Viaduct, London, England.

METEOROLOGICAL INSTRUMENTS.

Report.—Among the instruments exhibited is a very ingenious one for ascertaining the temperature of deep-sea soundings, which consists of a thermometer suspended by a horizontal axis passing through its middle, which, when the apparatus is drawn up, turns over and preserves separately the column of mercury which indicates the temperature. This arrangement is ingenious.

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260. C. W. Siemens, London, England.

PYROMETERS.

Report.—Commended for the general excellence of these instruments, devised by the inventor of the celebrated regenerative furnace.

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261. Lenoir & Forster, Vienna, Austria.

CARBONIC ACID APPARATUS.

Report.—An apparatus for liquefying carbonic acid, and also tubes used for illustrating the conversion of liquid carbonic acid into vapor by the heat of the hand, which this manufacturing establishment exhibits.

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262. Naudet & Co., Paris, France.

HOLOSTERIC BAROMETER.

Report.—Holosteric barometers of every description, carefully made, and of great endurance, from the plan of construction.

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263. G. A. Schultze, Berlin, Germany.

PHILOSOPHICAL APPARATUS.

Report.—Commended for excellent construction of philosophical apparatus, particularly barometers, thermometers, and boiling-point apparatus.

264. W. H. Pile & Sons, Philadelphia, Pa., U. S.

SPECIFIC GRAVITY APPARATUS, GRADUATED TUBES, ETC.

Report.—Commended for accurate construction of hydrometers of various kinds, specific-gravity bottles, chemical thermometers, graduated pipettes, and similar apparatus of precision for laboratory use.

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265. E. R. McKean, Washington, D. C., U. S.

GAUGING INSTRUMENTS FOR CASKS AND TANKS.

Report.—Commended for good adaptation and accurate manufacture of gauging instruments for casks, tanks, and cisterns, approved by experts.

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266. Eagle Square Manufacturing Co., South Shaftsoury, Vt., U. S.

STEEL SQUARES AND RULES.

Report.—Commended for accuracy of graduation and of angles, and general excellence of workmanship.

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267. Stanley Rule and Level Co., New Britain, Conn., U. S.

RULES, LEVELS, AND OTHER EXACT TOOLS.

Report.—Commended for the production, at low prices, of excellent rules, levels, plumbs, mitre-boxes, planes, plows, dados, and other carpenter tools. A standard manufacture of great merit.

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268. Gustav Blunck, New York, N. Y., U. S.

PARALLEL RULING MACHINE.

Report.—A very ingenious and original little machine for drawing parallel lines at equal intervals and at determinate angles; a valuable aid in mechanical and topographical drawing.

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269. Professor Robert H. Thurston, Stevens Institute of Technology, Hoboken, N. J., U. S.

MACHINE FOR TESTING STRENGTH OF MATERIALS.

Report.—This machine is built on exact scientific principles, and makes an automatic record of experiments to test the strength, elasticity, ductility, resilience, and homogeneousness of materials.

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270. Thomas Shaw, Philadelphia, Pa., U. S.

TEST GAUGE.

Report.—It is an admirable device for measuring great pressures by means of a column of mercury of moderate height, the difference of areas of two ends of a piston being made use of to reduce the height of the column.

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271. Osterheld & Eickemeyer, Yonkers, N. Y., U. S.

DYNAMOMETER.

Report.—The dynamometer invented by the exhibitors is an ingenious and useful device for measuring the average draft exerted upon agricultural implements, and meets a positive want in comparative tests of such appliances.

272. W. E. Desper & Co., Worcester, Mass., U. S.

WATER METER.

Report.—A double-piston meter, acting by displacement, with simple method of changing parts, durable in construction. It bore well the tests to which it was subjected, under pressure of from five to eighty pounds.

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273. National Meter Co., New York, N. Y., U. S.

THE "GEM" WATER METER.

Report.—This water meter commends itself by simplicity of construction and smallness of friction; it promises to be very durable. It sustained the tests of accuracy to which it was subjected, under pressures varying from five to eighty pounds, to the satisfaction of the judges.

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274. Samuel Archbold, Philadelphia, Pa., U. S.

THE MARSLAND WATER METER.

Report.—A very ingenious machine of the turbine type. It has only one movable part, which when in motion is supported by the liquid, and hence there are no rubbing surfaces. Although its indications are not obtained by the direct measurement of the water, they conformed well to the tests applied by the judges, under pressure of from five to eighty pounds.

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275. Fales, Jenks, & Sons, Pawtucket, R. I., U. S.

WATER METER.

Report.—Their "revolving piston meter" is positive in measurement and, in all its moving parts, of great capacity for its size. It performed very uniformly under the various pressures, of from five to eighty pounds, to which it was subjected by the judges.

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276. Union Water Meter Co., Worcester, Mass., U. S.

WATER METERS.

Report.—The exhibitors present two water meters of entirely different construction. No. 1 is a double-acting piston meter with a single concave rotary valve. No. 2 is a rotary piston meter of very ingenious construction. Both instruments possess great merit, and gave very satisfactory results under pressures varying from five to eighty pounds.

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277. I. W. Maclay, New York, N. Y., U. S.

THE FOUNTAIN WATER METER, NICOLAS AND CHAMON'S PATENT.

Report.—This is a displacement or piston meter of simple and apparently durable construction, and sustained well the tests to which it was subjected under pressures varying from five to eighty pounds.

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278. M. Hipp, Neuchâtel, Switzerland.

CHRONOGRAPHIC APPARATUS.

Report.—Commended for novelty of design and excellence of construction of an apparatus for registering the speed of railway trains, and of an instrument for measuring the swiftness of currents of water.

279. Prof. Tshebishef, St. Petersburg, Russia.

STRAIGHT LINE LINK MOTION.

Report.—The geometrically exact parallel motion by a combination of links, discovered by Prof. Tshebishef, is hese illustrated by several mechanical applications, among which those to the piston-rod of a steam-engine and to a universal governor are the most important. The principle involved is one of great importance, and reflects great credit upon its discoverer

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280. Alois Kreidl, Prague, Bohemia, Austria.

APPARATUS FOR SCIENCE SCHOOLS.

Report.—Commended for a very low-priced manufacture of instruments of illustration in science teaching, being at the same time of good quality; also for excellent laboratory apparatus.

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281. Wm. A. Rogers, Cambridge, Mass., U. S.

APPARATUS FOR PRODUCING EXTREMELY FINE AND UNIFORM GRADUATIONS, AND REGISTER TOOLS.

Report.—The exhibit of Mr. Wm. A. Rogers consists of the following apparatus, designed to meet the wants of science in the direction of extremely fine and accurate rulings and right-line or circular graduations, viz.:

1. Machine for polishing parallel surfaces on glass suitable for receiving microscopic rulings.
2. Machine for grinding and polishing diamonds used in ruling microscopical lines, including the means of finding the direction of the cleavage-planes, and of grinding a knife-edge on the diamond without danger of its crumbling.
3. Machine for ruling microscopic lines on glass, with various devices for securing steadiness and uniformity of motion, including magnetic clamps.
4. A reaction ruling machine, in which the slide is held by magnetic ways, with attachment for graduating circles on glass from one-quarter of an inch to fifteen inches diameter.
5. Specimens of etched rulings of various widths of lines, and of microscopic test-plates up to 80,000 lines to the inch.

The novelty of some of the devices employed, and the excellence of the results obtained, entitle the exhibitor to great commendation.

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282. Jas. W. Queen & Co., Philadelphia, Pa., U. S.

MATHEMATICAL AND DRAWING INSTRUMENTS AND MICROSCOPES.

Report.—Commended for the variety, accuracy, finish, workmanship, excellence, and cheapness of their instruments for the use of draughtsmen.

The microscope stands presented by the exhibitors are convenient and elegant, well finished in every respect, and remarkably cheap. The objectives, forming a series from one and one-half to one-fifth inch, give extremely satisfactory results, and are well adapted to the uses of working microscopists. They are likewise furnished at extremely low prices.

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283. J. L. Rose, Upsala, Sweden.

MAGNETIC MINING INSTRUMENTS.

Report.—Commended for the excellent construction of the magnetic apparatus for exploring iron mines, devised by Prof. Thalén.

284. Leopold Trouvelot, Cambridge, Mass., U. S.

ASTRONOMICAL DRAWINGS.

Report.—Commended for faithful delineation of celestial objects in thirty-four pastel drawings. These drawings have been made from actual observation with proper instrumental appliances, and their artistic execution is excellent. It may properly be said, without speaking disparagingly of what has previously been done, that for faithfulness in detail, even to the minutest, and for strict regard to the proper conditions of observation, these drawings are the best of the kind which have hitherto been made, and are worthy of special commendation.

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285. W. & L. E. Gurley, Troy, N. Y., U. S.

TRANSITS, LEVELS, AND COMPASSES.

Report.—This firm exhibits a large number of the instruments used in engineering, of various sizes and special adaptations, which all show excellent workmanship and great perfection in the mechanical as well as in the optical parts. A special claim is the successful application of a solar apparatus to the telescope of the engineer's transits for determining the true meridian; this form of the solar attachment possesses important advantages over other forms heretofore used, in admitting of more exact adjustment. Other claims are the introduction of means of adjustment for the slide carrying the object-glass of transit and leveling telescopes, and the first practical application of aluminium in the manufacture of field instruments, reducing their weight to about one-half, while on the other hand the cost is increased about forty per cent. These claims are well founded, and, together with the general excellence of the products, entitle the exhibitors to an award.

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286. Wm. Kuebler, Philadelphia, Pa., U. S.

SURVEYING INSTRUMENTS.

Report.—The transit theodolite and V-level combined is an instrument of new design, of special usefulness in certain cases, and is well constructed.

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287. Wm. J. Young & Sons, Philadelphia, Pa., U. S.

SURVEYING INSTRUMENTS AND ASTRONOMICAL CIRCLE.

Report.—The exhibit of this firm is of good construction and workmanship, and improvements in detail, of all classes of surveying instruments. The graduation of an astronomical circle of forty inches in diameter is shown by readings to have probably no error greater than two seconds, and demonstrates that the circular dividing engine, of their own construction, is capable of making first-class graduations.

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288. C. Fauth & Co., Washington, D. C., U. S.

ASTRONOMICAL AND SURVEYING INSTRUMENTS.

Report.—Commended for excellence in design and construction of the instruments exhibited, consisting of an eight foot equatorial telescope, completely mounted, with a six and a half inch object-glass by Alvan Clark & Sons; an alt-azimuth instrument, with twelve inch horizontal circle read by three, and ten inch vertical circle read by two micrometer microscopes with radial illumination, and provided with chambered levels of first-class accuracy; also a transit theodolite and a leveling instrument of lesser size.

289. Heller & Brightly, Philadelphia, Pa., U. S.

SURVEYING INSTRUMENTS.

Report.—This firm has lately become distinguished by improvements in the customary methods of constructing surveying instruments, such as the use of three leveling screws and other improved details, and by the construction of plane-tables of superior quality.

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290. Hydrographic Department, St. Petersburg, Russia.

SURVEYING AND OTHER INSTRUMENTS.

Report.—The instruments exhibited are of good design and execution; we note particularly an azimuth compass, with an illumination from above, ingeniously contrived.

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291. Hearn & Harrison, Montreal, Canada.

SURVEYING INSTRUMENTS.

Report.—The exhibit of mathematical and surveying instruments of their own construction is very creditable to this firm.

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292. E. Kraft & Son, Vienna, Austria.

SURVEYING INSTRUMENTS IN GENERAL.

Report.—Commended for excellent construction of surveying instruments for field and mines, with originality of design, and instruments for exact measurement, such as scales, and wire gauges.

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293. Lisbon Industrial Institute, Lisbon, Portugal.

SURVEYING AND DRAWING INSTRUMENTS.

Report.—A good collection of mathematical and electrical instruments, constructed at the Institute, of good design and workmanship.

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294. Bruto Limpo, Lisbon, Portugal.

LEVELING INSTRUMENT OF PRECISION.

Report.—Commended for excellent and novel design of a leveling instrument of precision, with two telescopes.

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295. Darling, Brown, & Sharpe, Providence, R. I., U. S.

STRAIGHT-EDGES, SCALES, SQUARES, AND WIRE GAUGES.

Report.—Commended for the great accuracy and fine workmanship of their U. S. standard rules, Ames' universal squares, hardened cast-steel try-squares, American standard wire gauges, bevel protractors, vernier callipers, and other similar products in which this firm excels.

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296. James Cremer, Philadelphia, Pa., U. S.

GRAPHOSCOPE.

Report.—The particular merit of this graphoscope is that by the means of a double-jointed arm it may be easily adjusted to any height or angle. The workmanship is also elegant.

297. Spectacle Makers' Society, Paris, France.

SPECTACLES AND MATHEMATICAL INSTRUMENTS.

Report.—The spectacles and eye-glasses exhibited are of excellent quality. The lenses are ground with remarkable precision. Of both a great variety of patterns are shown. The display of mathematical and drawing instruments is admirable. Those of the first class are unsurpassed in workmanship and finish by any in the market. There are also those of commoner qualities exhibited, and the prices throughout are extremely moderate.

298. Charles Feil, Paris, France.

OPTICAL GLASS, CROWN AND FLINT.

Report.—A pair of discs, crown and flint, of magnificent dimensions, and a series of admirable lenses and prisms of crown and flint glass, together with an interesting collection of trial specimens, and of artificial minerals and precious stones of great hardness, prepared by his processes.

299. Radiguet, Paris, France.

MIRRORS AND PARALLEL GLASSES; WORKING MODELS OF STEAM-ENGINES.

Report.—The display of mirrors, both silvered and black for polarizing, and his parallel glasses, are to be commended for excellence of material and workmanship. His model steam-engines are designed for toys, or for lecture-table illustration. They embrace various forms locomotive and stationary, and are very well made.

300. J. Hoel, Paris, France.

SPECTACLES AND EYE-GLASSES.

Report.—Commended for excellence of workmanship and variety and beauty of patterns. The so-called Galezowski eye-glasses are especially noticeable for their ingenious adaptation to the object, and comfortable fitting.

301. A. Lemaire, Paris, France.

OPERA GLASSES, MARINE GLASSES, AND HAND TELESCOPES.

Report.—The objects exhibited are of very superior workmanship and finish, and of great variety. The *jumelles de luxe* are many of them exquisitely beautiful, and some deserve, for their embellishments, to be ranked among works of art.

302. Lacombe, Paris, France.

OPERA GLASSES WITH ROUND OR OVAL LENSES.

Report.—The workmanship of these glasses is good, and the performance excellent. Much taste is shown in the designs, and the prices are noticeably moderate.

303. Chance Brothers & Co., Birmingham, England.

OPTICAL GLASSES.

Report.—Commended for the superior quality and large dimensions of the discs of crown and flint glass prepared by them for telescopic objectives. In the present exhibition they have a disc of hard crown glass, remarkably free from imperfections, of twenty-four inches diameter, and pairs of flint and crown of twenty, seventeen, and twelve inches, with others smaller, of apparently equal excellence. The display is one of great interest.

304. Lion & Guichard, Paris, France.

ANEROID BAROMETER.

Report.—Commended for cheap construction of aneroid barometers on an ingenious plan.

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305. Bardou & Son, Paris, France.

OPERA GLASSES, FIELD GLASSES, AND TELESCOPES.

Report.—Commended for superior quality of lenses and workmanship in every respect.

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306. S. Waldstein, Vienna, Austria.

OPERA GLASSES.

Report.—In these glasses an improvement is claimed, designed to relieve the strain on the eye sometimes experienced in the use of binocular instruments. The improvement consists in the introduction of a glass, slightly prismatic, immediately behind the eye-glass, and in contact with it, the bases of the prisms being outward. The effect is to cause the visual images to coalesce without effort on the part of the observer. For some persons there may be an advantage in this.

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307. S. Plössl & Co., Vienna, Austria.

OPTICAL INSTRUMENTS.

Report.—This firm exhibits optical instruments, viz., telescopes, polarization apparatus, etc., all of which show scientific execution, exactness, and first-rate workmanship.

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308. T. A. Willson & Co., Reading, Pa., U. S.

ARUNDEL TINTED LENS, SPECTACLES, AND EYE-GLASSES.

Report.—The processes employed in the preparation of the glass for the lenses, and in the construction of the frames, are new and ingenious. The discs for the lenses are moulded under pressure, securing uniformity of density. The tinted lenses are prepared according to a graduated scale of tints, which makes it possible to secure the same tint in lenses of different thicknesses. In the methods of constructing the frames are secured the advantages of simplicity, economy of material, elasticity, and strength. Steel is the only material used.

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309. Isaac Alexander, Washington, D. C., U. S.

IMPROVED FRAMES FOR EYE-GLASSES.

Report.—Commended for simplicity and originality in the expedient employed to adjust the position of the lenses of the eye-glasses to the eyes of the wearer. An elastic spring is attached to the frame of each lens, and is adjusted to the most suitable position by means of a small set-screw.

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310. L. Black & Co., Detroit, Mich., U. S.

SPECTACLE AND EYE-GLASS FRAMES.

Report.—Commended for ingenuity in the method of securing the lenses in the frames of eye-glasses and spectacles, by means of which the glasses may be introduced or removed with facility and without the aid of any tool. The fastening also holds the lenses very securely in their places. All the lenses of these makers are ground to the same exact size and form, so that one pair may be at any time replaced by another of different color or curvature without special preparation.

311. American Optical Co., Southbridge, Mass., U. S.

SPECTACLE AND EYE-GLASS FRAMES.

Report.—Manufacturers of gold, silver, steel, and nickel-plated steel spectacle and eye-glass frames of excellent workmanship, durability, good style and finish, in a great variety of patterns.

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312. Spencer Optical Manufacturing Co., New York, N. Y., U. S.

SPECTACLES AND EYE-GLASSES.

Report.—Commended for good workmanship, variety and elegance of patterns, and cheapness. The glass used is excellent in quality, and the frames of very various materials, including the metals, shell, rubber, and celluloid. The excellent temper of the steel frames is particularly noticeable.

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313. Alexander Beckers, New York, N. Y., U. S.

REVOLVING STEREOSCOPES.

Report.—These stereoscopes are well constructed, admitting a large number of pictures, and allowing two persons to observe at the same time. They are adaptable also to pictures of different widths, and are provided with expedients for screening the eyes and for shutting off the view of lateral objects. They may likewise be used for either opaque or transparent objects.

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314. Joseph Zentmayer, Philadelphia, Pa., U. S.

MICROSCOPES.

Report.—The microscope-stands of Mr. Zentmayer, for superiority of workmanship, rigidity and freedom from tremor, and the convenient arrangement of their moving parts, have long been regarded by observers as unsurpassed by any in use. In the present exhibition, besides the forms already familiar to microscopists, he has presented one which is substantially new, and which embodies a number of important improvements. In this the sub-stage, which carries the condenser or other illuminating apparatus, swings round a pivot of which the axis passes through the object observed, so that this object is in every position in the focus of the illumination. The principal stage rotates on the optical axis of the instrument, and, in case of error, is capable of accurate adjustment by means of set-screws. This stage may be detached with facility and replaced by a smaller one, called a diatom-stage, when the swinging illuminator may be used, if necessary, for illumination from above. The swinging sub-stage affords also a very easy method of measuring angular aperture, and is provided with a graduated circle for the purpose. The whole stand also rotates on its base, and by placing the body in a horizontal position, and by bringing the front of the objective into the line of the axis of rotation, angular aperture may be measured upon a horizontal limb, as in the stands earlier constructed by the same maker.

In the binocular the racking out is ingeniously arranged so as to compensate the inequality of distance between the objective and the two oculars produced by the Wenham prism. The rotating stage, making a complete revolution on the optic axis, was first introduced by Mr. Zentmayer, though it has since been copied by other constructors. It is graduated to serve as a goniometer. The object-carrier is a plate of glass kept down by a spring armed with a point which rests upon the glass. Motion is given to this by the hand. This simple and convenient contrivance, which is known as Zentmayer's object-stage, is extensively in use, and has also been copied by other makers. Instead of this object-carrier, the ordinary mechanically-moving stage may be substituted on this stand.

The fine movement focus adjustment acts on the entire body of the instrument, without disturbing in any manner the relative distance of objective, ocular, and binocular prism. This exceedingly ingenious stand is in every important respect original with the exhibitor,

and is presented as a characteristically American stand. Objectives are exhibited by Mr. Zentmayer of three inches focus, one and a half inch, one inch, eight-tenths inch, one-half inch, one-fourth inch, and one-fifth inch. These are not surpassed in defining power by those of any other maker. The resolving power of the one-fourth inch and one-fifth inch is also remarkable. The three inch objective is capable of being transformed into a four inch and a five inch, which latter will embrace an object an inch in diameter. A pocket microscope, which folds up without separation of parts into a case (which when in use forms its stand), small enough to be carried without inconvenience in the coat-pocket, is provided with a one-fifth inch objective, and admits the use of any other objectives provided with the Society screw. An admirable dissecting microscope is exhibited, provided with two single lenses of two and a half inches and one and a half inch respectively, and two Coddingtons of three-fourths inch and one-half inch, having a stage of nearly seven inches in diameter.

Of the numerous forms of apparatus accessory to microscopic observation exhibited by Mr. Zentmayer, may be mentioned, as especially worthy of commendation, a very ingenious erecting prism, a mechanical finger for picking up and arranging diatoms and other minute objects, and a parabolic mirror to be attached to the objective for the illumination of opaque objects, which purpose it answers much more satisfactorily than the Lieberkühn.

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315. T. H. McAllister, New York, N. Y., U. S.

PROJECTION LANTERNS AND MICROSCOPES.

Report.—PROJECTION LANTERNS.—These lanterns are well made, and are designed for use with calcium light produced by the oxy-hydrogen flame, or by oxygen with the spirit lamp. Oil lamp lanterns are also shown. The calcium light lanterns are provided with pressure regulators, which adapt them for use with cylinder gas reservoirs as well as with bags. Their view-holders are so constructed as to bring each view exactly to the centre of the field without any care of adjustment on the part of the operator, so that in exhibiting dissolving views, when the register of the two lanterns is once secured, it remains undisturbed under all the successive substitutions. The dissolving effect is very simply produced by turning a lever.

MICROSCOPES.—The stands are to be commended for their simplicity, convenience, and cheapness. There are four forms of these stands on exhibition, distinguished as the popular, the student's, the physician's, and the professional microscope. All of these have coarse and fine focus-adjustment movements, and the two last mentioned have sliding glass stages. The coarse adjustments are effected by a chain and pinion movement, instead of rack and pinion as is usual. This gives a smooth and steady motion, and would seem to deserve general adoption. In the physician's and the professional microscopes the fine adjustment screw moves the entire body.

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316. J. Duboscq, Paris, France.

SPECTROSCOPES, SACCHARIMETERS, HELIOSTATS, AND POLARIZATION APPARATUS.

Report.—His spectroscopes, heliostats, saccharimeters, and polarizing prisms are of the highest order of excellence. Especially admirable are certain Nicol and Foucault prisms of extraordinary dimensions and remarkable clearness of material. This collective display cannot be too highly commended.

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317. Derogy, Paris, France.

PHOTOGRAPHIC LENSES AND ACHROMATIC SPECTACLES.

Report.—The photographic lenses exhibited are especially excellent for the enlargement of charts, maps, plans, etc., being admirably corrected for distortion and for curvature of

image. The enlarged maps shown as executed by them are delineated with great sharpness of definition, and in just proportions. Some of these lenses are of great diameter. A crown glass meniscus is exhibited of seventy centimetres. The lenses of the achromatic spectacles exhibited are well achromatized.

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318. Darlot, Paris, France.

PHOTOGRAPHIC APPARATUS AND OPERA GLASSES.

Report.—The photographic lenses exhibited are designed both for portraits and for views. They perform very well, but are chiefly to be commended for their moderate prices. The opera glasses of the same exhibitor present a variety of tasteful patterns, and are of good quality. They also are sold remarkably cheap.

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319. Negretti & Zambra, London, England.

MICROSCOPES.

Report.—This firm exhibits a first-class microscope-stand, and a series of objectives from three inches to one-eighth inch. The stand resembles the Ross model, so long and favorably known, possessing all the convenient mechanical contrivances for the movement of the stage in co-ordinate directions and for rotation, as well as for the adjustment of the focus by quick or slow movement, and for illumination. It is extremely stable, and, to those who do not object to a considerable weight, will be found very satisfactory. The objectives embrace a series from three inches to one-eighth inch. The high powers are formed of a simple front and three achromatic combinations. Their performance with central light is creditable, but not of the highest order. The workmanship of the first-class stand, and of the objectives, is excellent. The second-class stand is well made, but less highly finished.

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320. Edmund Wheeler, London, England.

PREPARATIONS FOR THE MICROSCOPE.

Report.—These objects, which are very various in character, embracing insects entire, and parts of insects, tissues vegetable and animal, mosses, algæ, sections of wood, and minerals, are put up with great neatness and evident care.

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321. Thomas John Middleton, London, England.

TRIPLE LANTERN DISSOLVING VIEW APPARATUS, IMPROVED JET FOR LIME LIGHT, COLORS AND MATERIALS FOR PAINTING ON GLASS.

Report.—The three lanterns, placed vertically one above another, afford the operator considerably increased facilities for varying the effect, while the convenience of operation is materially improved. The fronts are telescopic, and adaptable to any distance between ten and one hundred feet. The method of dissolving by alternately shutting off and turning on the gas of the different jets is attended with a sensible economy. The new lime adjusters exhibited are deserving of commendation. The workmanship of this apparatus is excellent throughout. The colors and materials for painting on glass are of noticeably good quality.

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322. Rathenow Optical Establishment, Rathenow, Germany.

PHOTOGRAPHIC LENSES.

Report.—The corporation making this exhibit replaces Mr. Emil Busch, a constructor of eminence, by whom was invented the first view-lens having an angle larger than 90°. He has also constructed an excellent new aplanatic lens. Portraits and architectural views executed with these lenses are shown in the exhibition at Photographic Hall, which afford the best proof of their merit, and place them in the first class of objects of this description.

323. Henry Crouch, London, England.

MICROSCOPES.

Report.—A series of microscopic stands is exhibited, all constructed upon a common plan, which combines simplicity of design with all desirable stability and remarkable lightness. The simplest form, called the educational microscope, with or without rack-work or fine lever adjustments, is believed to be the cheapest form of microscope capable of real work in the market.

The student's microscope, monocular or binocular, with rack and lever adjustments, rotating glass stage, and various appliances for aiding manipulation and illumination, possesses nearly all the advantages desirable in a microscope for investigation, and is also remarkably cheap.

The first-class microscope, monocular or binocular, embraces mechanical adjustments of the stage in co-ordinate directions, complete rotation of the stage, rack and lever adjustments, graduated limb, graduated draw-tube, improved sub-stage, and every other desirable appliance for a complete instrument, and is furnished on terms similarly moderate.

It is an extremely convenient feature of these stands that the sub-stage may be removed by a lateral slide, by which is secured a great saving of time and trouble over the ordinary arrangements. The student's binocular was the first which was introduced to meet the wants of this class of observers. An important peculiarity of the rotating stages is the newly introduced centering adjustment, by means of which rotation about the optic axis is perfectly and instantaneously secured. A centering arrangement of the diaphragm is also provided. The objectives exhibited form a series ranging from three inches to one-fourth of an inch. For sharpness of definition and freedom from distortion of image they leave nothing to be desired. They are admirably adapted to all the ordinary work of the microscope. The polariscopes exhibited deserve especial commendation for their excellent mounting and large field.

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324. Ross & Co., London, England.

MICROSCOPES AND PHOTOGRAPHIC LENSES.

Report.—1. MICROSCOPES.—Two forms of first-class microscope-stands are exhibited, under the names of the Ross model and the Jackson model.

The Ross model has been long known. Its merits are great stability, effective mechanical arrangements for adjustment of focus and movement of object, facility of centering the sub-stage, and convenient position of the milled heads for working. It is an advantage, also, that the arm carrying the objectives can be turned aside, leaving the space above the stage entirely clear, and also that for convenience in packing for transportation this arm may be entirely removed.

The Jackson model differs from the Ross model in the body and bearings, but in respect to stage, sub-stage, and arrangement for illumination, is identical with it. The sliding posts and bearings are unusually broad and strong, securing great rigidity and freedom from tremor at the expense of increased weight. The perfect centering of the body and stages is secured by making a single stout bar the support of these, maintaining them therefore in an unvarying line. The distribution of weight is such as to produce a perfect balance. The positions of the milled heads are remarkably convenient, and such that the fine movement may be operated while the hand is on the coarse movement.

MICROSCOPE OBJECTIVES.—A complete series of these is exhibited from four inches to one-fifteenth inch. Those from one-half inch forward are constructed on a system introduced a few years since by Mr. Wenham, according to which a cemented triple achromatic combination is placed between two simple lenses. Certain theoretic advantages are claimed for these objectives. The low powers, especially the half inch, perform admirably, and the high powers do well with central or slightly oblique illumination. This firm have a series

in course of construction called new universal micro-objectives, of which a specimen of one-fifth inch focus is exhibited.

This objective is provided with two fronts, one of which used alone gives a low angle and long working distance, and reinforced by the other, a high angle adapted to difficult resolutions. This works dry, but by more closely approximating the two fronts, is converted into an immersion objective. Another one-fifth inch is also exhibited, which acts both as a dry and immersion glass, and with an additional front is increased in power and in sharpness of definition on difficult objects in consequence of its large angle. This also works both dry and wet, with proper adjustments.

2. Photographic Lenses.—Some of these are designed for portraits, and others for landscape, architectural, and interior views. One form, called the New Universal Lens, is designed for either use.

It seems to be unnecessary to speak of these in detail, since they all possess certain excellent qualities in common, such as flatness of field, sharpness of definition, depth of focus, freedom from distortion, and large angular aperture.

By the method of construction, also, they are made very compact, and the different lenses may be interchanged upon the same flange screw. The specimens of their performance on exhibition show a remarkable uniformity of definition, both in the foreground and in the distance.

The terrestrial telescopes and field-glasses of various kinds are of excellent workmanship.

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325. R. & J. Beck, London, England.

MICROSCOPES.

Report.—The objects exhibited are all of the highest excellence in respect to workmanship and finish. The microscope-stands exhibited are of four grades, adapted to different classes of observers. The first-class stand possesses the qualities of stability and freedom from tremor in the highest degree, the body, stage, and sub-stage being supported by a single bar of great rigidity. It is also well balanced. The arrangements for the mechanical movement of the stage, and for coarse and fine adjustments of focus, are extremely convenient. The student's microscope, or second-class stand, is simpler of construction, but possesses many of the advantages of that just described. The popular microscope is simpler still, and is furnished at a very moderate price; and, finally, the Economic microscope provides for most ordinary investigations in pathology and natural history, at a very insignificant expense. The objectives of this firm are well known for their merit. Of those exhibited, the performance of the one and a half inch and the one-tenth inch immersion is especially excellent; but all the low powers give remarkable penetration combined with sharp definition; and with the higher, difficult resolutions are easily effected. Of apparatus accessory to microscopic observation, the exhibitors manufacture a large variety, such as the polarizing apparatus, which is so constructed that the analyzer may be placed either above or below the eye-piece. The iris diaphragm is also an admirable contrivance for conveniently varying the diameter of the illuminating pencil.

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326. J. H. Dallmeyer, London, England.

MICROSCOPES AND PHOTOGRAPHIC LENSES.

Report.—1. Microscopes.—Two first-class microscope-stands are exhibited, a monocular and a binocular, together with apparatus for illumination, and a series of eight objectives, ranging from two inches to one-twelfth of an inch. The stands are of the pattern known as the Ross model. They are very massive, and combine strength with stability and convenience. The object-stage is mechanically moved in co-ordinate directions by rack and pinion and screw movements, and is rotated around the optic axis by means of a pinion working in a toothed ring. The sub-stage has centering and focus adjustments, and is also capable of

rotation. Of the workmanship and finish too much cannot be said in praise. The low-power objectives give excellent definition, superior penetration, and perfect flatness of field. The higher powers, from one-fourth inch upward to one-twelfth inch, are formed of three achromatic combinations with angular apertures, which are, theoretically, 125° for the one-fourth inch, 145° for the one-eighth inch, and 160° for the one-twelfth inch. Practically these angles are found to be sensibly less. Working dry, with central or nearly central light, excellent definition of difficult tests is obtained. The one-twelfth inch requires a cover not exceeding about one two-hundredths inch. Under oblique light, within the limit practically admissible, the resolving power and flatness of field are capable of improvement. Each of the high-power objectives is furnished with an additional front, by substituting which the glass is converted into an immersion objective, in which case the effective aperture is increased. By partially unscrewing the immersion-front, this immersion objective may be used dry with reduced angle.

2. Photographic Lenses.—Quite a variety of these lenses are exhibited, into the special merits and peculiarities of construction of each of which it seems to the reporters to be unnecessary to go. Their merits are attested by the extent to which they have been introduced into use in nearly all countries.

The large portrait lenses possess the very important property of being capable of adjustment for depth of focus, according to circumstances. This, which was first introduced in 1866, consists of a front combination formed of a double-convex crown and a concavo-convex flint cemented together, forming, unitedly, a convexo-concave system; and a back combination uncemented, consisting of a crown meniscus with a concavo-convex flint placed behind it. The mechanical approximation or separation of these last-mentioned glasses affords the means of the adjustment for depth of focus above spoken of. When the glasses are in contact, the aberrations are entirely corrected for a single plane. By their separation, *depth of focus* is secured to suit the particular occasion. This contrivance displays great ingenuity.

The lens called the *Triple Achromatic*, used for copying maps and plans of large dimensions, has been long in use. The forms called *Rectilinear*, which are of two kinds, *Rapid* and *Wide Angle Rectilinear*, are employed for groups, views, and landscapes. The first has an angle of 75°, and the second of 90°. The *Single Combination Landscape* lens is formed of two meniscus glasses of different kinds of crown glass, with an intervening flint concavo-convex, all cemented together. In use, the concave side of the system faces the landscape. It gives a picture free from flaw-spots with an angle of 70°, not entirely free from distortion on the borders, but with a brilliancy and uniformity of illumination which compensate this defect. Some very beautiful and sharply-defined pictures of the sun, with interesting groups of spots, taken at the Wilna Observatory with an instrument furnished by the exhibitor, are shown, and furnish a very satisfactory proof of the excellent performance of the photo-heliographic apparatus by means of which they were obtained. Commended for excellence of workmanship in the construction of achromatic telescopes, and for accessories and equatorial mountings for the same.

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327. Voigtlander & Son, Brunswick, Germany.

PHOTOGRAPHIC LENSES, OPERA AND MARINE BINOCULARS, AND TELESCOPES.

Report.—1st. Photographic Lenses.—Commended for the general excellence of their photographic lenses of all dimensions. A large number of their lenses are on exhibition here, of which the workmanship and finish are no less creditable than the optical character.

2d. Binocular Opera and Marine Glasses.—In these instruments the objectives and oculars are equally triple achromatic combinations. The adoption of this system of construction has made it possible to render the instrument much more compact than the form previously in use, by shortening the focus; and also to enlarge the field without reducing the defining or magnifying power.

3d. Terrestrial Telescopes.—The particular merit claimed for these instruments,

apart from their excellence of workmanship, consists in the reduction of the focal length with a given diameter object-glass, or the increase of the diameter of the objective with a given focal length. The result is a corresponding increase in the brightness of image, with an unchanged magnifying power. For the ordinary purposes of a terrestrial telescope this is a sensible advantage, though the definition is not quite uniform over the whole field. For geodetic purposes this want of uniformity of definition is of no consequence, since the definition in the centre of the field is sharp, which is all that is important in the observation of signals; and the superior light is advantageous, especially when the atmospheric conditions are unfavorable.

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328. A. Nachet, Paris, France.

MICROSCOPES.

Report.—The instruments exhibited by him are characterized by excellence of workmanship and by admirable qualities. Two of the forms which are of his own device are particularly noticeable, viz.: his binocular, by which the image may be made pseudoscopic if desired, affording the observer valuable assistance in determining the character of markings; and his inverted microscope, large model, in which the distance between the objective and ocular is from ninety to one hundred centimetres, while the stage is very near to the observer, and the illuminating apparatus is unobstructed by the interference of any part of the stand.

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329. Bausch & Lomb Optical Co., New York, N. Y., U. S.

OPTICAL APPARATUS, LENSES, MICROSCOPES, TELESCOPES, SPECTACLES, AND EYE-GLASSES.

Report.—Commended for superiority of workmanship and excellence of finish of the collective exhibit, and the admirable performance of the particular instruments.

For the large variety and excellence of the lenses wrought from glass and rock crystal for optical experiments, and of the reading-glasses and magnifiers for the hand and pocket.

For original and valuable improvements in microscopic stands and their appendages.

For the remarkable compactness and portability of the pocket, dissecting, and botanical microscopes.

For the large variety and excellence of the spectacle and eye-glass lenses, and for the variety of forms of the mountings, by which they are adapted to any configuration of face or features.

For an original, expeditious, and accurate method of determining the focal distances of lenses whether concave or convex, and the simplicity and ingenuity of the apparatus employed for that purpose.

For the moderate prices of the various objects exhibited, especially of the microscopes and microscope stands.

In illustration of the foregoing recommendations, it may be remarked:

1. That the lenses are of all sizes, from fifteen inches in diameter downward, and embrace spherical, prismatic, cylindrical, and plano-curved glasses for correcting abnormal conditions of vision; achromatic and Coddington magnifiers of a variety of dimensions; and reading-glasses, and large lenses for optical demonstrations.

The material, though not manufactured by the exhibitors, is of excellent quality, having been selected with care. The rock crystal lenses are free from blemish.

2. That the microscope stands possess the valuable properties of stability, firmness, and compactness. The method of attaching the diaphragm is such as to make it equally available for direct or for oblique illumination. The fine movement adjustment is upon a plan entirely new, and extremely simple, which has the merit of being altogether free from friction, lost motion or change in the length of the body. The condenser exhibited under the name of an immersion condenser is also wholly original, and is a valuable addition to the resources of the microscopic observer. It has the form of a solid glass cone truncated

at the vertex with a base of spherical curvature; a drop of water connects the truncated vertex with the slide, and the light from the illuminating source falls perpendicularly on the base, whether central or oblique to the axis.

3. The great variety of spectacle and eye-glass lenses are prepared and arranged for exhibition in a manner which deserves commendation. Sections of all of them have been made through the centre and mounted, so as greatly to facilitate examination of their peculiarities. The frames for these glasses are constructed according to a system of varying forms, which makes it possible to select one which will bring the lenses centrally before the eyes of any person, whatever the conformation of his countenance.

4. The apparatus for determining focal lengths consists of a portable dark chamber, having a single aperture at which the lens to be examined is placed, and a sliding screen within, on which the image falls. A scale at the side of the box gives the focal length. The scale may be made for parallel rays, as for light received from the sun, but is usually calculated for an observed object at a determinate distance. The scale readings, however, are always the principal focal lengths. When a concave lens is to be determined, it is combined with a convex lens of superior curvature, of which the curvature is known.

The prices of the microscope stands are so low as to enable observers of very moderate means to provide themselves with good instruments.

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330. Argentine National Observatory, Córdoba, Argentine Republic.

LUNAR PHOTOGRAPHS.

Report.—The photographs of the full moon and last quarter exhibited, having forty-eight centimetres diameter, show excellent definition. They are carbon prints, enlarged from the original negatives of 3.52 centimetres diameter, taken with an eleven and a quarter-inch photographic object-glass, made upon the method of Rutherfurd by H. Fitz.

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331. J. J. Wilson, New York, N. Y., U. S.

STEREOPTICONS, OR PROJECTION LANTERNS.

Report.—These lanterns are, in respect to workmanship and finish, probably the best exhibited. Some peculiarities of construction distinguish them favorably. They are designed for calcium lights, and the arrangements for the adjusting of the lime and the jet are simple and easily managed. By means of a triple condenser (one lens of which can be removed if necessary) the light may be brought very near to the object, while a thin glass screen protects the condensing lens from the heat. The instrument may be used for vertical projection, and when the diagonal mirror employed for this purpose is removed, the triangular protecting sides may be folded down upon the face of the mirror, securing them against accident and facilitating packing. For transportation, the whole apparatus may be quickly packed in a small space.

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332. Wilson, Hood, & Co., Philadelphia, Pa., U. S.

PHOTOGRAPHIC APPARATUS.

Report.—The objects most noticeable in this exhibit are certain instruments, or rather machines, for cutting prints to the sizes and forms required for mounting. They operate with great precision, a property indispensable to the usefulness of such contrivances. They are, therefore, to be commended for their ingenuity and simplicity of design, and for their excellence of workmanship.

Very stable head-rests are also shown, and likewise embossing presses and revolving stereoscopes of good quality.

333. D. A. Woodward, Baltimore, Md., U. S.

SOLAR CAMERAS.

Report.—The solar camera is designed to print enlarged copies from small photographic negatives, precisely as enlarged images are produced from small objects by the solar microscope. The sunlight, as in the instrument last named, may be directed through the optical system by reflection, or it may be received upon the condensing lens directly. The cameras exhibited illustrate both methods of operation. They are very strongly constructed of wood and iron, but chiefly of iron. The specimens of the work of the solar camera, on exhibition in Photographic Hall, are very fine. Professor Woodward is entitled to the credit of having originated this very effective method of photographic reproduction.

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334. John Stock & Brother, New York, N. Y., U. S.

PHOTOGRAPHIC CAMERAS AND CAMERA-STANDS.

Report.—In addition to the general excellence of workmanship of the objects exhibited, it may be said of the cameras that they have several ingenious peculiarities which recommend them to the operator. After the focal adjustment has been made, the position of the image on the screen may be changed without disturbing the focus. In focusing, a lever gives a convenient slow movement which makes accurate adjustment easy. A very commendable improvement is also an internal leaf or shutter which permits the instantaneous opening or closing of the camera by turning the milled head of a pin. A very convenient camera-stand is also exhibited, which admits of adjustments in elevation and inclination requiring no clamps, and which, in addition, has the great merit of portability, as it is capable of being folded up flat in small compass.

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335. L. D. Sibley & Co., Vineland, N. J., U. S.

STEREOSCOPIC ALBUM AND STEREOSCOPE.

Report.—This so-called stereoscopic album consists of a number, greater or less at pleasure, of light metallic frames holding stereoscopic views, the frames being strongly hinged together, so that, on being placed in a stereoscope specially constructed for them, the views may be successively and easily turned up for examination. When out of use, the box may be shut up compactly, inclosing the views. The views are not liable to injury from contact and friction, as the joints are very firm.

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336. Scovill Manufacturing Co., New York, N. Y., U. S.

PHOTOGRAPHIC APPARATUS.

Report.—The workmanship and finish of this apparatus cannot be too highly commended. All the instruments are distinguished by ingenious and original contrivances for facilitating manipulation. Among these may be mentioned the automatic fastenings for securing the plate-holders, the tangent screws for adjusting the position of the screen in inclination and in azimuth, and the lever contrivance for quick and sure focusing in the portrait cameras. Also the simple and ingenious cameras for working in the field with dry plates, and the exceedingly compact forms of plate-boxes for the same use. The camera for views called the "cone-view camera" has the advantage of economizing material and diminishing weight. The new form of camera-stand recently introduced by this firm is adjustable to any altitude and any inclination with the utmost facility, is perfectly stable, and holds its position without clamps.

337. E. Gundlach, New York, N. Y., U. S.

MICROSCOPE OBJECTIVES.

Report.—Commended for the superior defining and resolving power of the microscope objectives. The microscope objectives exhibited range from four inches focus to one twenty-fourth inch. It is in the higher powers that the skill of the optician is chiefly shown. The one-tenth inch and one twenty-fourth inch were most particularly and severely examined, and were found to be admirably corrected for color and for flatness of field, and to possess a defining and a resolving power which leave nothing to be desired.

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338. Wm. Wales, Fort Lee, N. J., U. S.

OBJECTIVES FOR THE MICROSCOPE.

Report.—These objectives are unsurpassed by any known to the reporters for all the qualities desirable in microscopic objectives. There are in the series exhibited nine glasses, varying from four inches to one-twenty-fifth of an inch. The low powers give great penetration, with sharp definition and perfect flatness of field. The higher, with equal definition, resolve the most difficult tests heretofore attempted. Mr. Wales was the first optician to construct an objective capable, by screw-collar adjustment, of working equally well wet or dry. The first glass made by him on this principle was produced in 1867.

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339. W. H. Walmsley, Philadelphia, Pa., U. S.

MICROSCOPIC OBJECTS.

Report.—The objects, which belong mostly to natural history, are remarkable for perfection of parts and for clearness and neatness of mounting. The different tissues in the vegetable organisms are brought out by double staining with aniline colors and carmine. By mounting in glycerine jelly the natural colors of many are perfectly preserved.

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340. Samuel Peck & Co., New Haven, Conn., U. S.

PHOTOGRAPHIC APPARATUS AND GRAPHOSCOPES.

Report.—A head-rest of a new pattern in this exhibit has great stability, and possesses several peculiarities which add to its usefulness. Its sliding parts are nickel-plated and admirably finished. There is also exhibited a "resetting-stand" for working upon negatives, which is very convenient, bringing out the print of the negative strongly by illumination from beneath while at a proper angle for working. Graphoscopes of convenient forms and various sizes are shown, which may be commended for their excellent workmanship.

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341. George D. Beatty, Baltimore, Md., U. S.

SLIDES OF STAINED VEGETABLE TISSUE PREPARED FOR THE MICROSCOPE.

Report.—The objects are preparations of vegetable tissues, shown mostly in sections and stained by immersion in colored solutions, the structures anatomically different taking up different colors. The staining not only adds to the beauty of the object, but facilitates investigation. The preparations are admirably neat and clear.

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342. E. & H. T. Anthony & Co., New York, N. Y., U. S.

1. PROJECTION LANTERNS. 2. IMPROVED GRAPHOSCOPE. 3. HAND STEREOSCOPE AND MEGASCOPE.

Report.—The projection lanterns are of several forms and variously named, as micro-scientific lantern, stereo-panopticon, university stereopticon, artopticon, etc.; most are designed for lime light, but in some a coal oil lamp is employed. The most complete are

adapted to vertical as well as to horizontal projection. For the lime-light lanterns are provided gas holders and manometers or pressure gauges. The lime is also slightly rotated and raised by the act of introducing the slide, so as to require only occasional attention from the operator. The workmanship is throughout very creditable.

The graphoscope is in several respects an improvement on the forms of the instrument heretofore in use. 1. When not in use it may be folded up compactly, protecting the lenses, and rendering it easy of transportation. 2. The sliding parts are of metal and unaffected by atmospheric moisture causing adhesion. 3. It is adjustable to large or small views, the lens being brought in either case equally to the centre of the view. 4. The mechanical contrivances for adjusting the instrument to any required angle are new and convenient.

The megascope does not differ in principle materially from the graphoscope, but is designed to magnify somewhat more. The magnifying power may be obtained by one lens or by a combination of lenses. In the instruments exhibited a single lens only is used. To increase the power or to adapt the instrument to long-sighted eyes, an additional magnifier may be brought before the observing lens, or turned out of the way when not needed.

The hand stereoscopes present no novelty, but are well finished.

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343. S. W. Robinson, Illinois Industrial University, Champaign, Ill., U. S.

ODONTOGRAPH.

Report.—The odontograph of Professor S. W. Robinson is a simple and convenient means of describing the proper form of teeth of geared wheels, with very nearly true geometrical exactness, and its use must greatly tend to improve the work of millwrights and machinists.

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344. Workshop of the Baltic Light-House Board, St. Petersburg, Russia.

LIGHT-HOUSE LAMP.

Report.—Commended for the good construction of the lamp for light-houses, on the system of Fresnel, for the Baltic Sea.

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345. D. Carette-Dobbels, Meulebeke, near Courtrai, Belgium.

LIGHTNING RODS.

Report.—1. It is constructed on well-established principles, including all the facts which science has discovered bearing on the protection from accidents by lightning. It consists of a principal rod of wrought iron, which metal is a sufficiently good conductor for electricity of high tension, is cheaper than copper, and not liable to be melted, as the latter is, by a heavy discharge of lightning. 2d. The principal part of the rod is cylindrical, which form, being free from salient edges, is the best for transmitting a discharge without danger from lateral diversion. The part of the rod which is elevated above the roof is slightly tapering, to present a less resistance to the wind. 3d. The rod is covered with a coating of metallic paint, which prevents rusting, and does not interfere with the transmitting power of the conductor. It is terminated above by a single platinum point, which from theory as well as direct experiment is known to produce a greater effect in directing the path of a discharge than several points terminating the same rod. 4th. To insure a good connection with the earth, the rod is terminated below in five branches projecting into moist earth or water.

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346. Geo. B. Grant, Boston, Mass., U. S.

TABULATING CALCULATING MACHINE, OR "DIFFERENCE ENGINE."

Report.—This machine for computing and tabulating mathematical tables, such as logarithms, sines and tangents and their logarithms, reciprocals, square and cube roots, etc., possesses great merit for the simplicity and certainty of its action and for the ease with which its parts can be adapted to the requirements of any given function.

347. Geo. B. Grant, Boston, Mass., U. S.

ARITHMOMETER.

Report.—The arithmometer is a calculating machine for common operations in multiplication and division. It is simple in construction, not liable to get out of order; its use greatly saves the mental labor of computation, and lessens the liability to error. It is deemed superior to all other instruments of its class yet produced.

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348. H. Olland, Utrecht, Netherlands.

METEOROGRAPH.

Report.—The object of the instrument exhibited, of which Prof. Baumhauer is the author, is to transmit and record at a central observatory conditions of the weather at places of difficult access, or where observers cannot permanently reside. It is well adapted to this object, and is ingenious and efficient.

---

349. Wm. W. Goodwin & Co., Philadelphia, Pa., U. S.

GAS METERS.

Report.—The exhibit consists of a series of articles for the measurement of the quantity of gas, for the estimation of its illuminating power, and for testing its purity. The articles are reliable in their indications, and so arranged as to be readily applicable in practice. They are essential to the public inspector of city gas.

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350. Harris, Griffin, & Co., Philadelphia, Pa., U. S.

GAS METERS.

Report.—The exhibit consists of a series of meters, from the largest size for the use of the manufacturer of gas to those for the use of the ordinary consumer. The instruments are well made, reliable as to indications, and embody a number of improvements which, with the general character of the exhibit, entitle the whole to commendation.

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351. D. Farrand Henry, Detroit, Mich., U. S.

CURRENT METER AND INLET PIPE AND STRAINER FOR WATER-WORKS.

Report.—Commended for an improvement on the ordinary form of current meters and the application of electricity to the recording part of the instrument; also for the arrangement of a strainer and inlet pipe for water-works, so as to prevent the interruption from the accumulation of anchor ice.

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352. Prof. S. W. Robinson, Illinois Industrial University, Champaign, Ill., U. S.

DIVIDING MACHINE FOR UNEQUAL PARTS.

Report.—It supplies a great desideratum, by rendering practicable and easy the division of thermometer and hydrometer scales into increasing or decreasing parts, as the calibre of the tube may require. The machine is well made, and is already in use by some of the principal makers of such instruments.

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353. Geo. M. Eddy & Co., Brooklyn, N. Y., U. S.

MEASURING TAPES.

Report.—Commended for possessing an excellent temper and great accuracy in graduation; also the manufacture of superior band-saws by the same method of tempering.

354. **Royal Mint of Portugal, or "General Administration of the Mint and Stamped Paper," Portugal.**

COINS AND MEDALS.

Report.—Commended for good coinage and artistic execution, especially of the Camoens medal and that of Louis of Bavaria.

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355. **Bruecker & Bauler, St. Petersburg, Russia.**

KEROSENE BURNER.

Report.—An arrangement for supplying a mixture of kerosene gas and atmospheric air to a Bunsen burner, useful in laboratories where there is no coal gas.

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356. **Prof. Modeste Kittary, St. Petersburg, Russia.**

DYNAMOMETER AND NAPMETER FOR CLOTH.

Report.—The apparatus for testing the strength and wear of woolen cloth, by Prof. Kittary, adds to the usual instrument for measuring the tensile strength of the fabric, a new device for testing the nap, which must be of great value to inspectors of clothing.

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357. **Jerome B. Secor, Bridgeport, Conn., U. S.**

CAGES OF ARTIFICIAL SINGING BIRDS.

Report.—Commended because of ingenuity of the apparatus employed and the success attained.

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358. **Pratt, Read, & Co., Deep River, Conn., U. S.**

IVORY KEY-BOARDS.

Report.—Commended for excellent workmanship.

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359. **Prof. Jamin, Paris, France.**

POWERFUL STEEL MAGNET.

Report.—A magnificent magnet, constructed of steel plates designed by Mr. Jamin (the kind which is used with marked success in the Gramme magneto-electric machines with permanent magnets), is exhibited, carrying a weight of four hundred and fifty milligrammes, or about four times its own weight.

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360. **Henry S. Tarr & Son, Philadelphia, Pa., U. S.**

MASONS' AND CARPENTERS' DRY-LEVEL.

Report.—The invention and construction of a level for the use of masons and carpenters, in which the indication is effected by a loaded wheel, with a graduated rim, showing inclinations.

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361. **J. Kern, Aarau, Switzerland.**

DRAWING INSTRUMENTS AND THEODOLITES.

Report.—German-silver drawing instruments, and theodolites and other surveying instruments, of excellent workmanship and comparatively low price.

362. Kassian Schäfer (Ludwig Heisinger), Nuremberg, Germany.

MATHEMATICAL DRAWING INSTRUMENTS.

Report.—His exhibit of low-priced instruments is distinguished by careful workmanship.

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363. Geo. Schoenner, Nuremberg, Germany.

MATHEMATICAL DRAWING INSTRUMENTS.

Report.—Distinguished by the cheapness of the exhibited products.

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364. Clemens Riefler, Maria Rhein, near Kempten, Germany.

MATHEMATICAL INSTRUMENTS.

Report.—Commended for good manufacture of mathematical drawing instruments at moderate prices.

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365. A. Israilef, Rostov, Government of Yaroslav, Russia.

TUNING FORKS.

Report.—Commended for an exhibit of a series of tuning forks for the use of schools.

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366. Alvergniat Brothers, Paris, France.

CHEMICAL AND PHYSIOLOGICAL APPARATUS.

Report.—Commended for ingenuity of device and excellence of workmanship.

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367. T. Alteneder, Philadelphia, Pa., U. S.

DRAWING INSTRUMENTS.

Report.—Very carefully made drawing instruments, with improvements of original design.

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368. E. S. Ritchie & Sons, Boston, Mass., U. S.

PHILOSOPHICAL APPARATUS.

Report.—A large exhibit of philosophical apparatus for illustration and research, of excellent construction.

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369. Ferdinand Lotz, Offenbach, Germany.

ENGRAVING MACHINES.

Report.—Commended for excellence of machinery for engraving on steel, copper, or stone, ruling machines, and geometric lathes for engraving dies.

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370. Karl Traiser, Darmstadt, Germany.

MACHINES FOR ENGRAVING.

Report.—Commended for excellent construction, on correct principles, of machinery for engraving in cut and relief right lines, waved lines, and combination curves of all orders, the construction involving novel principles of importance.

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371. Imperial Mint, St. Petersburg, Russia.

COINS AND MEDALS.

Report.—Commended for the excellent mechanical execution and artistic design of a collection of coins and medals of the Russian Empire.

372. A. J. Petersson, Christiania, Norway.

CALCULATING MACHINE.

Report.—An ingenious and convenient machine for performing automatically the ordinary operations of arithmetic.

373. Charles Verdier, Paris, France.

TIME, FARE, AND DISTANCE INDICATOR FOR CARRIAGES.

Report.—Commended as an indicator for carriages, which shows by a dial and pointer, for the tariff fixed, the amount of hire which has accrued at any instant, the time occupied, and also the distance traversed. The machine also marks upon a fillet of paper the distance passed over. The movement indicator is in relation to time controlled by a clock movement, and in relation to distance by air compressed in a flexible tube connected with a bellows and ratchet and wheel-work, and operated at each revolution of the carriage wheel. This indicator is compact, easily understood, reliable in its indications, and durable.

374. L. J. Marcy, Philadelphia, Pa., U. S.

LIME-LIGHT SCIOPTICON AND OIL-LIGHT SCIOPTICON.

Report.—These are projection lanterns with original and ingenious arrangements. In the lime-light lantern a disc of lime two inches in diameter and more than half an inch thick is employed, with its axis horizontal rather than vertical, as in the more usual form. The oxygen jet is a flattened tube, giving breadth to the compound flame, which may be either a hydrogen or an alcohol flame. The arrangement for instantaneously changing the pictures, though simple, is a very useful improvement. The oil-light lantern is provided with two broad wicks which give separate flames, deflected near to each other, but not into actual contact, a current of air arising between them; the flames pass into what is called a flame chamber, by which the reservoir is screened from the heat, the extremities of the chambers being glazed. There are other contrivances displaying ingenuity and deserving commendation, such as those for tinting the pictures and for veiling and unveiling the views.

375. Keuffel & Esser, New York, N. Y., U. S.

DRAWING INSTRUMENTS AND MATERIALS.

Report.—The drawing instruments, scales, squares, triangles, and mechanical models for schools, of their own manufacture, are well made and worthy of an award.

376. Chameroy & Co., Paris, France.

SCALE BEAMS WITH REGISTERING APPARATUS.

Report.—Commended for manufacture of wagon scales provided with a simple and convenient apparatus for embossing directly from the scale beam, upon suitable tickets, the weight indicated, by which time is saved and chances of error are lessened.

377. Stevens Institute of Technology, Hoboken, N. J., U. S.

EDUCATIONAL ESTABLISHMENT.

Report.—Commended for completeness in appliances and thoroughness in its course, as evidenced by the character of the work produced by its students, consisting of designs, drawings, and finished machines and instruments. It is also entitled to consideration for the numerous original investigations which it has enabled its various professors to pursue, and which are represented by their published papers, and, when practicable, by specimens exhibited.

378. Wm. Knabe & Co., Baltimore, Md., U. S.

CONCERT AND PARLOR GRAND, SQUARE, AND UPRIGHT PIANOS.

Report.—Commended for general excellence in the requirements of a first-class instrument; in power, richness, and singing quality of tone, touch, and solidity of construction. All four kinds of pianos show intelligent arrangements, a very effective action, and excellent workmanship.

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379. Francisco Coello y Quesada, Madrid, Spain.

MAPS OF SPAIN AND HER COLONIES.

Report.—A valuable atlas of Spain and her colonies, compiled and engraved by the exhibitor; an enterprise of great magnitude for an individual, and one of great public usefulness.

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380. Steinway & Sons, New York, N. Y., U. S.

METAL WARE.

Report.—They exhibit in Machinery Hall samples of metal parts, hardware, and full metal frames of grand, square, and upright pianos; also samples of their patent metallic tubular frame actions, all produced at their foundry and metal works at Astoria, Long Island. These articles of composite metal show the highest perfection of finish and workmanship, and the greatest firmness and uniformity of metal structure, a steel-like and sounding quality, with a tensile strength exceeding 5000 pounds per square centimeter, as demonstrated by actual tests. The full metal frames of cupola shape possess an unequaled degree of resistance, permitting a vastly increased tension of strings without the slightest danger of break or crack in said metal frames, thereby considerably increasing the vibratory power and augmenting the lasting qualities of their instruments.

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381. Francisco Collantes de Terán, Seville, Spain.

COINS AND MEDALS.

Report.—Commended for artistic design and finished execution of a large number of coins and medals engraved by the exhibitor, chiefly for the Government of Spain.

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382. Chickering & Sons, Boston, Mass., U. S.

CONCERT-GRAND, UPRIGHT, AND SQUARE PIANO-FORTES.

Report.—Their grand piano is of a quick, elastic touch, of broad and clear resonance, with the utmost power of utterance that its class affords, consistently with securing a pure, delicate, and singing quality of tone. Their other instruments, specimens of the everyday production of their establishment, possess highest qualities in fullness of volume, delicacy of tone, elastic response of touch, with thoroughness of workmanship. These several characteristics, and the acknowledged excellence attained by this firm, entitle them to an award. They claim to be the successful applicants of an iron frame to all classes of these instruments, also the original inventors of the circular scale for piano-fortes.

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383. T. A. Edison, New York, N. Y., U. S.

ELECTRIC PEN AND DUPLICATING PRESS.

Report.—The electric pen and duplicating press is a combination of apparatus which produces the same results as those produced by lithography. It requires no skilled expert to produce perfect work. The apparatus is the invention of Thomas A. Edison.

The electric pen consists of a small electro-magnetic engine, mounted upon a framework,

secured to the top of a tube pointed at the end. Within the tube is a common needle, fastened to the end of a wire, which is given an exceedingly rapid vertical motion by cams upon the rotating engine shaft. This needle is projected from the small end of the tube at the rate of fifty times per second. If the pen be held upon a sheet of writing-paper placed on common blotting-paper, a letter may be written as fast, and with a little experience as easily, as with an ordinary pen, but the characters, unlike those formed with the ordinary pen, will be composed of innumerable holes punctured in the paper by the rapid projection of the needle from the tube. The result is a perfect paper stencil, which, treated precisely as an ordinary stencil, will give similar result. The motive power used to drive the engine of the pen is derived from a voltaic battery. This battery consists of two Bunsen cells, the principle of which was discovered by the celebrated chemist Bunsen, and for power and convenience has never been excelled. A particular form of this battery was especially designed by Mr. Edison for the Electric Pen, with a view to economy and its use by persons inexperienced in electricity. It is provided with a lifting arrangement whereby the battery plates may be raised from the exciting fluids when not in use, thus preventing consumption of materials.

The current from the battery is conveyed to the engine by two wires insulated from each other, and placed in a single flexible cord, thus giving a free movement to the pen.

A neat stand for holding the pen when not in use is provided with the apparatus.

After the stencil has been prepared, it is a very simple matter to obtain a great number of perfect fac-similes of the original writing.

The press consists of a metal base, with a perfectly smooth top, upon which the sheet to be printed is laid. A frame operating upon hinges and having several clamping springs for securing the stencil in position, is brought down upon the bed of the press. A roller formed of felt, saturated with ink, is passed back and forward over the stencil sheet until the holes become filled with ink, and deposit it upon the paper underneath. The result is a perfect fac-simile of the original writing, and presenting an appearance far superior to writing done with an ordinary pen. The same process can be repeated until enough copies are obtained. More than six thousand copies have been printed from a single stencil.

The simplicity of the whole apparatus, and the results obtained by it, entitle it to a place among the really useful inventions of the age. Lithography cannot compete with it in the ease, rapidity, and cheapness with which a number of copies of a letter, circular, etc., may be prepared for the purposes of ordinary commercial business.

With this system two hundred copies of an ordinary circular, price list, etc., can be written, printed, and mailed within one hour.

As almost anything that can be done with an ordinary pen may be done by the use of this apparatus, it follows that the press is adapted to the uses of nearly all trades.

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384. Fred. Gysi, Aarau, Switzerland.

DRAWING INSTRUMENTS.

Report.—Good mathematical drawing instruments.

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385. Society of Portuguese Architects and Archæologists, Lisbon, Portugal.

JOURNAL OF THE SOCIETY OF PORTUGUESE ARCHITECTS AND ARCHÆOLOGISTS.

Report.—The journal of the society exhibits great activity on the part of members; it contains very valuable memoirs, and is illustrated in good style. Being the first institution of the kind in Portugal, it is worthy of commendation. The medal for awards by the society, designed by the Chev. J. da Silva, its founder, possesses great artistic merit.

SIGNING JUDGES OF GROUP XXV.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

Sir WILLIAM THOMSON, 1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 181, 195, 221, 230, 231, 234, 235, 240, 247, 359, 383.

H. K. OLIVER, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 69, 70, 71, 72, 73, 74, 75, 76, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 97, 98, 99, 100, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 115, 116, 117, 118, 119, 120, 121, 122, 123, 125, 126, 127, 129, 130, 131, 132, 133, 134, 135, 136, 137, 357, 358, 378, 380, 382.

J. E. HILGARD, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 218, 219, 220, 222, 223, 224, 225, 227, 228, 239, 241, 242, 243, 244, 245, 248, 249, 250, 251, 252, 255, 256, 257, 258, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 286, 287, 288, 289, 290, 291, 293, 294, 295, 304, 305, 311, 330, 343, 344, 346, 347, 352, 353, 354, 355, 356, 360, 363, 364, 365, 366, 368, 369, 370, 371, 372, 375, 376, 377, 379, 381, 385.

JAS. C. WATSON, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 164, 165, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 238, 284, 373.

JOSEPH HENRY, 23, 253, 345, 348, 349, 350, 351.

P. F. KUPKA, 105, 285, 307.

ED. FAVRE PERRET, 163, 166, 167.

J. SCHIEDMAYER, 64, 65, 66, 67, 68, 78, 96, 101, 114, 124, 128.

E. LEVASSEUR, 226, 229, 237, 246, 254, 259, 260, 261, 283, 292, 361, 362, 367, 384.

GEO. F. BRISTOW, 77.

CHAS. E. EMERY, 10.

F. A. P. BARNARD, 2, 232, 233, 236, 282, 296, 297, 298, 299, 300, 301, 302, 303, 306, 308, 309, 310, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 331, 332, 333, 334, 335, 336, 338, 339, 340, 341, 342, 374.

SUPPLEMENT TO GROUP XXV.

REPORTS
OF
JUDGES ON APPEALS.

JUDGES.

JOHN FRITZ, Bethlehem, Pa.
EDWARD CONLEY, Cincinnati, Ohio.
CHARLES STAPLES, JR., Portland, Me.
BENJ. F. BRITTON, New York City.
H. H. SMITH, Philadelphia, Pa.
COLEMAN SELLERS, Philadelphia, Pa.
JAMES L. CLAGHORN, Philadelphia, Pa.
HENRY K. OLIVER, Salem, Mass.
M. WILKINS, Harrisburg, Oregon.
S. F. BAIRD, Washington, D. C.

1. Negretti & Zambra, London, England.

THERMOMETERS.

Report.—Commended for excellence of high-grade instruments. The deep-sea thermometer of this firm is worthy of especial mention.

2. Henri Zimmermann, Paris, France.

ORGAN PIPES.

Report.—Commended for the excellent quality of material employed, skill and precision of workmanship, and thorough adaptedness to the purposes intended.

3. Emile Mennesson, Paris, France.

TWO VIOLINS.

Report.—Commended for power and purity of tone, with good workmanship and economy of cost.

4. Placht Brothers, Vienna, Austria.

VIOLINS.

Report.—Commended for good tone, well-treated wood, and great economy of cost.

5. Gavioli & Co., Paris, France.

AUTOMATIC ORCHESTRION.

Report.—Commended as well adapted for the purpose intended.

6. Fortin Brothers, Paris, France.

FELT CLOTHS FOR HAMMERS OF PIANO-FORTES.

Report.—Commended for excellence of material and workmanship, and firmness combined with the requisite suppleness.

7. T. B. Granjon, Paris, France.

VIOLIN FOR USE OF TRAVELERS.

Report.—Commended for utility, convenience, and fitness for the purpose intended.

8. A. Santucci, Verona, Italy.

BRASS BAND INSTRUMENTS.

Report.—Commended for full and rich resonance of tone and excellence of workmanship.

9. C. Ponti, Venice, Italy.

A BINOCULAR TELESCOPE.

Report.—Commended for excellence of construction and adaptation to purpose intended.

10. Luigi Venturini, Padua, Italy.

STRINGS FOR VIOLINS, CELLOS, AND HARPS.

Report.—Commended for their good material, strength, and good make.

11. A. E. Dolbear, Boston, Mass., U. S.

PHYSICAL APPARATUS.

Report.—Commended for ingenuity and novelty in apparatus for physical experiments.

12. August Perrott, Philadelphia, Pa., U. S.

A TONOGNOME AND MUSIC CARDS FOR USE IN MUSIC CLASSES IN PUBLIC SCHOOLS.

Report.—It is an ingenious and convenient apparatus for use of teachers of music classes in public schools in giving and preserving the pitch of the voices. The music cards are well adapted to their purpose.

13. Theodore Schmitz, New York, N. Y., U. S.

SEAMLESS BRITANNIA MEASURES.

Report.—Commended for good workmanship (being made of one piece of metal), and fitness for purposes intended.

14. Charles Missenharter, New York, N. Y., U. S.

BAND INSTRUMENTS.

Report.—Commended for excellence of workmanship, accuracy of tone, with far-reaching power.

15. Sohmer & Co., New York, N. Y., U. S.

SQUARE PIANO-FORTES.

Report.—Commended for volume, purity and evenness of tone, elastic touch, and good workmanship

16. Stephen Chester, New York, N. Y., U. S.

CHESTER FIRE-ALARM TELEGRAPHS.

Report.—This system of alarm telegraph is worthy of commendation for the following reasons: It consists of a series of ingenious inventions for improving the application of its several parts to the purposes intended; for facilitating the operation of the system; for rendering the whole more permanent; and for determining the point at which any break may have occurred in the continuity of the conductors.

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17. Taylor & Farley Organ Co., Worcester, Mass., U. S.

PARLOR ORGANS.

Report.—Commended for accuracy in workmanship, evenness, purity, and brilliancy of tone, uniformity in power, and general utility of mechanical appliances for the purposes intended.

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18. Knox & Shain, Philadelphia, Pa., U. S.

ENGINEERING AND TELEGRAPH INSTRUMENTS.

Report.—Commended for excellence of design and workmanship of telegraphic registers and improved transit.

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19. S. W. Robinson, Champaign, Ill., U. S.

TOOL FOR CUTTING OUT PHOTOGRAPHS.

Report.—This is a convenient rotary cutter, to be used (with turnplate) in cutting out labels or photographs. Commended for utility and fitness.

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20. Haines Brothers, New York, N. Y., U. S.

UPRIGHT AND GRAND PIANO-FORTES.

Report.—Commended for superior quality of tone, evenness of scale, elasticity of touch, and general good workmanship.

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21. E. R. McKean, Washington, D. C., U. S.

GAUGING IMPLEMENTS.

Report.—Commended for precision of operation and saving of labor in accomplishing the object intended.

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22. G. W. Ingalls & Co., Worcester, Mass., U. S.

REEDS AND REED-BOARDS FOR PARLOR ORGANS.

Report.—They are well made, of good material, and well adapted to the purpose in tended.

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23. Henry F. Miller, Boston, Mass., U. S.

GRAND, SQUARE, AND UPRIGHT PIANO-FORTES; PEDAL ATTACHMENT TO UPRIGHT PIANO-FORTES.

Report.—Commended for excellence in general workmanship and for good quality of tone, as well as elasticity of touch; also a pedal attachment to upright piano-fortes, commended for utility, convenience, and fitness for purpose intended.

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24. Mrs. H. C. Dobson, New York, N. Y., U. S.

BANJOS.

Report.—The instruments, a noteworthy improvement on the ordinary kind, are excellent in material and workmanship, and full, resonant, and effective in tone.

25. **Albrecht & Co., Philadelphia, Pa., U. S.**

GRAND AND SQUARE PIANO-FORTES.

Report.—Commended for clear, pure, and equal tone, and elasticity of touch, with general excellence of workmanship.

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26. **C. F. Martin, Nazareth, Pa., U. S.**

GUITARS.

Report.—Commended for excellence of tone and good workmanship.

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27. **Mrs. M. J. Coston, Washington, D. C., U. S.**

TELEGRAPHIC NIGHT SIGNALS.

Report.—Commended for ingenuity of construction and excellence of performance.

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28. **J. W. Hile, Waterville, Marshall County, Kansas, U. S.**

A CENTURY CLOCK.

Report.—Commended for ingenuity of design of escapement and pendulum.

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29. **Imhauser & Co., New York, N. Y., U. S.**

TIME DETECTOR FOR WATCHMEN'S USE.

Report.—Commended for portability, security, and general adaptation to the purpose intended.

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30. **Carl Lehnert, Boston, Mass., U. S.**

CYMBALS AND GONGS.

Report.—Commended for good workmanship and clearness of resonance.

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31. **Eugene F. Phillips, Providence, R. I., U. S.**

TELEGRAPHIC OFFICE WIRES.

Report.—Commended for marked excellence of material and workmanship.

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32. **John Chatillon & Sons, New York, N. Y., U. S.**

SCALES.

Report.—Commended for excellence of spring balances.

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33. **C. A. Schindler, West Hoboken, N. J., U. S.**

PIANO-FORTE STOOLS.

Report.—Commended for novelty, strength, and fitness for the purpose intended, with economy of cost.

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34. **Casimiro de Bona, Spain.**

NAUTICAL INSTRUMENTS.

Report.—1st. For azimuth apparatus, or instrument for hydrographical and nautical observations. The merit of this instrument consists in its enabling one operator to make two

observations needed to ascertain position of vessel near a shore. It can also be used to find the variation of the magnetic needle by measurement of the angle with the point of the vessel.

2d. "Alidada Siderea" and "Alidada Solar." The merit of these instruments consists in their simplicity, cheapness, and convenience, allowing the determination of the variation of the magnetic needle, the hour and latitude being known, without the aid of calculation. For utility and fitness for the purposes intended.

SIGNING JUDGES OF SUPPLEMENT TO GROUP XXV.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

SPENCER F. BAIRD, 1, 9, 18, 21, 27, 28, 29.

H. K. OLIVER, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15, 17, 20, 22, 23, 24, 25, 26, 30, 31, 32, 33.

CHAS. STAPLES, JR., 13.

COLEMAN SELLERS, 19, 34.

JOSEPH HENRY, 16.

United States Centennial Commission.

INTERNATIONAL EXHIBITION,

1876.

REPORTS AND AWARDS

GROUP XXVI.

EDITED BY

FRANCIS A. WALKER,

CHIEF OF THE BUREAU OF AWARDS.

PHILADELPHIA:

J. B. LIPPINCOTT & CO.

1877.

SYSTEM OF AWARDS

[*Extract from Circular of April* 8, 1876.]

Awards shall be based upon written reports attested by the signatures of their authors.

The Judges will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the Commission of each country and in conformity with the distribution and allotment to each, which will be hereafter announced. The Judges from the United States will be appointed by the Centennial Commission.

* * * * * * * * * * *

Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Each report will be delivered to the Centennial Commission as soon as completed, for final award and publication.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress, and will consist of a diploma with a uniform Bronze Medal, and a special report of the Judges on the subject of the Award.

Each exhibitor will have the right to produce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

ORGANIZATION AND DUTIES OF THE JUDGES.

[*Extract from Circular of May* 1, 1876.]

Two hundred and fifty Judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the Groups to which they have been respect ively assigned. The foreign members of this body have been appointed

by the Commission of each country, in conformity with the distribution and allotment to each,. adopted by the United States Centennial Commission. The Judges from the United States have been appointed by the Centennial Commission.

To facilitate the examination by the Judges of the articles exhibited, they have been classified in Groups. To each of these Groups a competent number of Judges (Foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the Departments of Agriculture and Horticulture, which will form temporary exhibitions, have been arranged in special Groups, and Judges will be assigned to them hereafter.

The Judges will meet for organization on May 24, at 12 M., at the Judges' Pavilion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

The Judges assigned to each Group will choose from among themselves a Chairman and a Secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a Judge in each Group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed, by a majority of the Judges in such Group.

The reports of the Judges recommending awards based on the standards of merit referred to in the foregoing System of Awards, must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the Judges on the subject of the Award, together with a Diploma and a uniform Bronze Medal.

Upon matters not submitted for competitive trial, and upon such others as may be named by the Commission, the Judges will prepare reports showing the progress made during the past hundred years.

Vacancies in the corps of Judges will be filled by the authority which made the original appointment.

No exhibitor can be a Judge in the Group in which he exhibits.

An exhibitor, who is not the manufacturer or producer of the article exhibited, shall not be entitled to an award.

The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the Judges. Upon request, he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the Commission relating to awards, subject to an appeal to the Commission.

A. T. GOSHORN,

Director-General.

[*Extract from Director-General's Address to Judges, May* 24, 1876.]

"The method of initiating awards which we have adopted differs in some respects from that pursued in previous exhibitions. In place of the anonymous verdict of a jury, we have substituted the written opinion of a Judge. On this basis awards will carry the weight and guarantees due to individual personal character, ability, and attainments, and to this extent their reliability and value will be increased. It is not expected that you will shower awards indiscriminately upon the products in this vast collection. You may possibly find a large proportion in no way raised above the dead level, nor deserving of particular notice. The standard above which particular merit worthy of distinction begins is for you to determine. In this regard I have only to express the desire of the Centennial Commission, that you should do this with absolute freedom, and when you meet with a product which you consider worthy of an award, we desire you to say, in as few words as you may deem suitable, why you think so.

"This, gentlemen, is all we ask of you in the Departments of Awards. Opinions thus expressed will indicate the inherent and comparative merits, qualities, and adaptations of the products,—information which the public most desires.

"Elaborate general reports and voluminous essays, though of great value as sources of general information, give little aid in determining the reliable or intrinsic merits of particular, individual products.

"The regulations which have been published divide the work of awards into three parts:

"1st. The individual work of the Judges.

"2d. The collective work of the groups of Judges.

"3d. The final decisions of the United States Centennial Commission in conformity with the acts of Congress.

"Each award will thus pass three ordeals, which, doubtless, will be ample and satisfactory."

GROUP XXVI.

JUDGES.

AMERICAN.	FOREIGN.
JAS. B. EADS, C.E., New Orleans, La.	Sir JOHN HAWKSHAW, C.E., F.R.S., Great Britain.
WM. B. FRANKLIN, Hartford, Conn.	EDOUARD LAVOINNE, France.
RICHARD M. HUNT, New York City.	J. M. DA SILVA COUTINHO, Brazil.
GEORGE E. WARING, JR., Newport, R. I.	J. G. W. FYNJE, Netherlands.
	LOURENCO MALHEIRO, M.E., Portugal.

GROUP XXVI.

ARCHITECTURE AND ENGINEERING.

(*For Agricultural Engineering, see Class 680.*)

(*For Mine Engineering, see Group I.*)

ARCHITECTURE.

The construction and arrangement of the interior of dwelling-houses, hotels, public buildings, churches, and buildings for special purposes. Fire-proof structures and methods of building.

CLASS 342.—The dwelling,—sanitary conditions and regulations. Systems of water supply, drainage, heating, lighting, and ventilation. (For apparatus and fixtures, see Group XIV.)

CLASS 341.—Models and drawings of finished buildings, of market houses and markets, of hospitals, bath houses, gymnasiums, etc.

ENGINEERING.

CLASS 330.—CIVIL ENGINEERING.

Land surveying, public lands, etc.

River, harbor, and coast surveying. Construction and maintenance of roads, streets, pavements, etc. Surveys and location of towns and cities, with systems of water supply and drainage. Arched bridges of metal, stone, brick, or beton. Trussed girder bridges. Suspension bridges. Canals, aqueducts, reservoirs; construction of dams. Hydraulic engineering, and means of arresting and controlling the flow of water.

Submarine constructions, foundations, piers, docks, etc.

CLASS 331.—DYNAMIC AND INDUSTRIAL ENGINEERING.

Construction and working of machines; examples of planning and construction of manufacturing and metallurgical establishments.

CLASS 322.—RAILWAY ENGINEERING.

Location of railways, and the construction and management of railways.

CLASS 333.—MILITARY ENGINEERING.

CLASS 335.—CHARTS, MAPS, AND GRAPHIC REPRESENTATIONS.

Topographical maps. Marine and coast charts.

Botanical, agronomical, and other maps, showing the extent and distribution of men, animals, and terrestrial products.—Physical maps.

Meteorological maps and bulletins. Telegraphic routes and stations. Railway and route maps. Terrestrial and celestial globes. Relief maps and models of portions of the earth's surface. Profiles of ocean beds and routes of submarine cables.

GENERAL REPORT

OF THE

JUDGES OF GROUP XXVI.

INTERNATIONAL EXHIBITION,
Philadelphia, 1876.

PROF. FRANCIS A. WALKER, *Chief of Bureau of Awards:*

SIR,—I have the honor to submit reports on the Architectural and Engineering displays in the International Exhibition.

Respectfully yours,
GEO. E. WARING, JR., *Secretary.*

GROUP XXVI.

ARCHITECTURE AND ENGINEERING.

THE ARCHITECTURAL EXHIBITS OF THE INTERNATIONAL EXHIBITION.

BY R. M. HUNT.

While the United States Centennial Exhibition offered a varied and interesting display of the cognate arts of architecture, it is to be regretted that the purely architectural exhibit, viewed either æsthetically or as an art of construction, was far from realizing the just hopes and expectations of those interested in this noble art, especially when we consider the extent, grandeur, and variety of the monumental works undertaken and executed since the first "World's Fair," in 1851. I beg, therefore, to ask consideration, in the first place, to some of the effects occasioned by the great architectural revival since 1851, —the natural outgrowth of the first International Exhibition, and the succeeding ones of London, Paris, and Vienna. One of the most useful and practical benefits of these great Fairs is the familiar manner in which the industrial arts have been presented to the general public as well as the specialist, and which has been of the greatest possible service in educating and cultivating laymen as well as in instructing professional students.

And what has so told upon the individual mind has, in a larger way, influenced municipalities and corporations; resulting in the greater attention paid to sanitary science of late years,—the elaborate and thorough system of sewerage and drainage; the lighting of our houses and streets with gas; telegraphic communication and rapid transit; the introduction of healthful and plentiful supplies of water and air into the midst of centres of population; to all of which little or no thought was given formerly, but which now are deemed of paramount importance in the construction of our modern cities.

In the various capital cities of Europe the narrow, tortuous, dismal streets of the middle ages, which existed almost intact until a quarter of a century ago, have made way for broad and noble thoroughfares

in harmony with the requirements of the day. Edifices are erected after the *new*, not the *old*, and the spirit of improvement, which the conventionalist and the antiquarian call the "curse of the age," tears down the damp old walls, and air and sunshine now pour in where disease and crime once held high festival.

The cry was loud in Paris when Baron Haussmann, under Napoleon III., opened his boulevards right and left, giving breathing-space to its population of millions. And many a traveler to-day sighs in Rome over the strong-limbed Piedmontese who are laying the sewers and drains under the new régime, to drive away the very fever which might send the same traveler home shorn of his strength, a sadder and a wiser man. He sighs because the lazy, dirty, charmingly picturesque Roman peasant is being pushed out of sight.

It cannot be denied that some quaint and picturesque nooks and corners have disappeared, nor that certain historical landmarks have been obliterated; but, as a general rule, monuments of historical interest or artistic value have been preserved and repaired, even reconstructed, particularly in France and under the Empire, which restored with great minuteness of detail chateaux and churches fast crumbling away under the heavy foot of time.

Even in our new country, where so much remains to be accomplished, many systematically find fault with this so-called mania for modern improvements which must grow out of the wants and requirements of modern civilization, and with us in a peculiar degree out of the rapid growth of large cities and manufacturing towns, where cause and effect follow each other with a rapidity unknown in the Old World.

The architects of this country have accomplished much in this direction, and yet it is a fact hardly to be denied that the profession does not hold in this country the elevated position it has always held in Europe. Their task is, however, a peculiarly difficult one, for it is no easy matter, in a new country, to enlist the sympathies of the general public beyond the attainment of the most material results, and not until art education has become more general can we hope for that sympathy and consideration which is only born of knowledge.

But already there is a promise of better things; a few technological and industrial art schools are in successful operation, and the first steps have been taken towards the art education of the masses; while in this Centennial year we have just cause to congratulate ourselves upon the establishment of art museums similar to that of the South Kensington, in London, in several of our larger cities, and we may reasonably hope that our Exhibition will stimulate and improve all

our art-industries, as the first World's Fair improved those of Great Britain.

Having thus alluded to some of the important bearings which International Exhibitions have on modern progress, and before considering the architectural exhibits contained in the various buildings, a few words about the locality and the buildings themselves may not be amiss.

The Exhibition grounds in Fairmount Park, which possess the most striking natural advantages, comprise about 240 acres, and are on an elevated plateau traversed by two small streams flowing into the Schuylkill River. This admirably-adapted site, well wooded and picturesque, has rather the form of an irregular, equilateral triangle, the south side of which is occupied by the Main Building and Machinery Hall, while Memorial, Horticultural, and Agricultural Halls are on the north side, with the Women's Pavilion, the United States Government Building, and most of the State buildings grouped towards the northwest. Interspersed among these are about two hundred structures, comprising Commissioners' buildings, those for the special exhibits, cafés, restaurants, bazaars, etc. The grounds are tastefully laid out as a landscape garden, with asphalted roads and walks following the natural contour of the land. A few broad, straight avenues, furnishing a more direct communication between the most important points, are wisely introduced, and form a grand and noble feature; while, on account of the vast extent of the grounds and the great distance between the buildings, a novel feature, that of a passenger railway running in close proximity to the principal buildings, has been introduced.

The Exhibition buildings, with few exceptions, are well adapted to their various purposes, and are appropriate in design and neatly executed. It is to be regretted, however, that more attention was not paid to the various structures erected by the different States and by special exhibitors. With the exception of a few typical structures,—mostly erected by foreign nations,—little can be said in commendation in fact, the great majority are beneath criticism, architecturally considered, whereas a proper attention to this important subject would have added much to the exterior beauty of the Exhibition.

Without entering into minute details of the various buildings of the Exhibition, a few general remarks may not here be inappropriate.

The Main Exhibition Building is parallelogram in form, and covers an area of more than 20 acres. It is 1880 feet long, 464 feet wide, and 70 feet high, and was erected in about eighteen months, at a cost of $1,580,000. The principal nave, 120 feet wide, extends between

the galleries located at either end, and is accompanied by two others, each 100 feet in width, with intervening and outside aisles respectively 48 and 24 feet wide. Similar naves, with intervening aisles, cross the building in the middle. Iron columns, placed 24 feet apart lengthwise of the building, support the wrought-iron trusses of the roof, which is covered with tin. The flooring is of plank laid on sleepers resting directly on the ground, with no open space beneath, a precaution against fire,—a complete system of water-supply and drainage being also provided for protection against such a contingency and for sanitary purposes. The sides of the building are filled in between the columns with brick-work to the height of seven feet, with glazed sash above, a portion of which are movable for ventilation. Louvre ventilators are also introduced over the main naves, together with skylights. The general effect of the building is satisfactory, considering its temporary character and the consequent imposed restriction as to cost, and also in view of the materials used,—glass and iron. It should be here stated that the columns and trusses are so designed as to enable them to be taken down and used elsewhere. As might be expected, there is a total absence of anything like monumental grandeur or even apparent substantiality about the building. A certain stiffness and stringy monotony pervades the whole structure, while the relative height as compared to the vast area covered produces a squatty appearance. The façades, with their central features and corner towers connected by lower galleries in front of the main walls, are somewhat relieved of their monotony by pleasing effects of light and shade. The central portion, carried up with its towers, forms an appropriate crowning to the general mass. The interior is light and pleasing, but wanting in effect and variety. The spectator, taking in, as he does, at a glance the entire space, fails to appreciate the extent and vastness of the ensemble. The ground-plan of the Paris Exhibition of 1867, with its concentric oval naves and radiating aisles, presenting an ever-changing variety, was far more satisfactory in this respect, besides being better adapted for the classification of the various exhibits, either in groups or as national exhibits. The abandonment of any similar plan is to be attributed to the great loss necessarily sustained, as the mass of the materials, at Paris, when taken down, could be put to no practical use.

MACHINERY HALL.

Machinery Hall, also a parallelogram in form, is 1402 feet long and 360 feet wide, and covers an area of about 14 acres. It was erected in nine months, at a cost of $542,300. Two main avenues 90 feet wide,

70 feet high, and 1360 feet long (the distance between the galleries occupying the ends of the building) are accompanied by one intervening and two side aisles each 60 feet wide and 40 feet high. A transept 90 feet wide crosses in the middle of the building and extends beyond the main hall; this is flanked by aisles 60 feet wide, and forms an annex for hydraulic machinery. On account of the great similarity in plan between this and the Main Building, the effect produced is much the same. The interior of Machinery Hall, however, appears more substantial, due in part to the use of wood in its construction; while great praise is due to the admirable arrangement of the Hydraulic Annex, which forms so marked a feature.

AGRICULTURAL HALL.

Agricultural Hall was erected in about eight months, at a cost of $260,000, and is 820 feet long, 540 feet wide, and covers an area of over 10 acres. The main nave is crossed at intervals and at right angles by three similar ones, all constructed of Howe-truss arches of Gothic form; the spaces between these naves, which occur at the four corners of the building also, form, as it were, so many covered courts. The disposition of this building is well adapted to its purposes, and it owes much of the effectiveness of its interior to its grand arches springing directly from the ground,—a very satisfactory feature, contrasting favorably with the stilted and rather unstable appearance of the perpendicular supports employed in the two buildings just alluded to.

The United States Government Building, with its naves and aisles in the form of a Latin cross, and the Women's Pavilion, in the form of a Greek cross, with accompanying corner courts at the angles, respectively cover an area of 102,840 square feet and 26,368 square feet. These constructions are of wood, and effective in their appearance. This is particularly due to their disposition in ground-plan, which represent types so familiar to us all.

Among the minor temporary structures worthy of passing notice are a United States Post Hospital and an Ordnance Laboratory Building. This latter structure consists of a wrought-iron frame riveted together, and is covered with a light wood casing. In the event of an explosion only the roof and sides would be carried away, while the frame would stand to protect the inmates against injury from falling materials.

A peculiar feature to be observed in the Art Annex Building is the communication between the numerous rooms, which is provided for

in the angles. Good hanging-space is thus gained, but at the expense of considerable perplexity to the visitor.

The State Buildings of Ohio, New Jersey, Massachusetts, and Connecticut are to be commended, the two latter being in the style of the old colonial homes of New England, the former representing types of our modern country-houses. In the Ohio Building a great variety of the building-materials of that State are cleverly introduced. The New York State Building is truly remarkable from quite another point of view, and may be intended as a representation of the "new American style or order of architecture, based on hexagonal principles," models of which form a curious exhibit in the Agricultural Hall.

A marked contrast exists between most of these State structures and those of England, Germany, Sweden, France, and Japan, all of which are very praiseworthy, and typical in design and execution.

A few words, in conclusion, about those of the Exhibition buildings which are destined to remain, viz., Memorial and Horticultural Halls. The latter, constructed in the Moorish style, is appropriately located on a terrace. On either side of a central conservatory 230 feet by 80 feet, and 55 feet high, are forcing-houses. The ends of the building are devoted to reception- and dining-rooms, offices, etc. Four principal entrance-vestibules occupy the middle of the four sides; from these stairs lead to the interior and exterior galleries above. In the basement, which is fire-proof, are the kitchens, store-rooms, heating apparatus, etc. This building, with an area for exhibition purposes of 122,500 square feet, was built in eleven months, at a cost of $300,000. The ensemble is satisfactory, especially when viewed at an angle; the curved surfaces of the glass roofs of the forcing-houses gracefully harmonizing with the middle portion above, which is surmounted by a lantern.

Memorial Hall, erected by the State of Pennsylvania and the city of Philadelphia, is by far the most pretentious structure on the Exhibition grounds. It is fire-proof, and covers about an acre and a half, being 365 feet by 200 feet, and is 59 feet high over a basement 12 feet in height. Its cost was $1,500,000, and twenty months were employed in its construction. It is hereafter to be used as an industrial art museum to be inaugurated at the close of the Exhibition. The principal entrance-vestibule, 82 feet by 60 feet and 53 feet high, opens into a grand central hall, 83 feet square and 80 feet high; the square dome above rising exteriorly to the height of 150 feet. On either side of this central hall are located the main galleries, 98 feet long and of the same width as the hall. These are flanked by cross-galleries at

the ends, 89 feet by 28 feet, which extend between the pavilions at the corners. In the rear, the spaces between the corner pavilions and the central entrance are devoted to studios and small exhibition-rooms, with a communicating corridor. The latter rooms, also those in the corner pavilions, are lighted by side lights; in the remainder of the building skylights are used. Open arcades are happily introduced in the principal façade, which extend from either side of the main vestibule to the corner pavilions; these arcades form covered promenades and at the same time serve as screens to the blank walls of the galleries. The intervening spaces between these arcades and the outer wall of the main galleries are laid out in garden-plots. At a certain distance the general effect of the masses is rather satisfactory; but upon a nearer approach the building, constructed of granite in the Renaissance style, loses much, the ornamentation being very commonplace and meagre in design, and leaves much to be desired in execution. Great defects also exist in the interior distribution, among the most flagrant of which is the poor accommodation of the upper stories in the corner pavilions. Greater simplicity in design and breadth of treatment with less ornamentation would undoubtedly have produced a nobler effect and been more in harmony with the material used—perhaps not the most appropriate. A want of scale also pervades the details throughout; this is especially observable in the main central hall, the dome of which rests clumsily on the walls.

In view of the fine and varied exhibits made in painting and sculpture, and of the numerous and interesting displays in the art-industries, it can hardly be said that their sister art of architecture has been fairly represented at the Centennial Exhibition, the designs being few in number and mostly of minor importance. This may be somewhat accounted for by the fact that architectural designs and projects of construction have often necessarily only a local interest; while the technical character of architectural drawings prevents them from being appreciated, or even properly understood, by the general public; and, again, to the great number of architectural publications which have sprung into existence within a few years, containing everything of interest to the profession, may be attributed the meagreness of the exhibits. Owing to these and other causes, geometrical drawings, of such paramount importance, have gradually been superseded by perspective views, while the latter too often have been, as on this occasion, supplanted by photographic views of the finished structures, so that the handiwork of the architect, so far at least as the design is concerned, is wholly ignored.

In consequence, the Exhibition is wanting in much that would

render it interesting and instructive, not only to the profession but to a large class of the public, who would certainly appreciate the thoroughness, both in architectural design and construction, which prevails abroad, and which is wanting with us, due to a more scientific and judicious use of the various building-materials, and to the higher standard of taste which naturally exists in the Old World.

As compared with the exhibits of other nations, one is struck with the ambitious pretension of our designs, overloaded as they too often are with meretricious ornament. Another salient feature is the attempt to produce novelty of effect, often resulting in a want of harmony and repose, so essential to good work. A certain insane desire to carry up some portion of a building to an excessive height was remarked upon by foreigners, who naïvely inquired why it was that Americans did thus, and why a "petit bon-homme" was so often stuck on the top of our buildings. Without wishing to particularize, I cannot refrain from alluding to the satisfactory exhibit made by the State of Massachusetts. Complete sets of geometrical drawings accompany the perspective views of the various buildings. Among other projects of merit may be mentioned, as worthy of especial notice, designs for a college, a grammar-school, a hospital, an insane asylum, and an abattoir. The brilliant display made by Great Britain in the other art departments renders the poverty of her architectural exhibit all the more striking. The design for the decoration of St. Paul's, London, and that of the new Exchange building, Liverpool, the most important exhibits, are both wanting in simplicity and breadth of treatment. In the former there is a total absence of that repose so desirable, not to say absolutely necessary, to secure that sublime grandeur and dignity which should stamp such work. The latter, in the French Renaissance style, is greatly deficient in originality of design, and in thoroughness of treatment in the general distribution of the masses of the façade, the relative importance of its principal features, and in its ornamentation. Excepting some designs by Burges and Spiers, those of the latter decidedly French in treatment, and one or two other designs, a certain crudeness prevails in the English exhibit. It is but fair to add that but few of the prominent members of the profession in England have contributed.

This reflection applies with still greater force to the French contribution, where two rejected designs alone are worthy of particular notice, one being a noble and imposing project for the church of the Sacré Cœur, at Montmartre, by Crépinet, and the other a project for the Théâtre de la Renaissance, in Paris, by Lalande, which latter is notable for the talent shown in overcoming difficulties occasioned by

the restricted and irregular shape of the ground-plot. We must except also the Orleans Railway Station, in Paris, by Reynaud, a work of great importance and merit in design, and remarkably well rendered; also certain designs and models of light-houses, exhibited by the Ministry of Public Works, but which more properly belong to the engineering exhibit.

When we reflect upon the numerous and grand edifices erected by such men as Duc, Lefuel, Questel, Millet, Garnier, Ballu, and upon the thorough and remarkable restorations made of late by Duban and Viollet le Duc, we cannot fail to deplore that France has been so inadequately represented. Considering, also, the grandeur and importance of the architectural work done in Vienna by Schmidt, Hansen, Ferstel, and others, our disappointment is great indeed at seeing their grand achievements only in photography.

Russia exhibits a well-studied design of a cathedral church, not treated, unfortunately, in the Russo-Byzantine style, but rather in the Lombard, so prevalent on the borders of the Rhine. Belgium's only exhibit is also a design for a cathedral, in the Gothic style, thoroughly studied, the drawings of which are remarkably well rendered.

The projects exhibited by Italy and Spain, with one or two praiseworthy exceptions, are notable rather for their originality, even eccentricity at times, than for competent handling.

The architectural exhibit of Switzerland, though consisting mostly of designs of minor importance, is more complete than that made by any other country, nearly every canton being represented. Designs of hospitals, schools, asylums, and other public institutions predominate. They are generally noteworthy for the ability shown in their ground-plans, which are generally well adapted to their various requirements. But few attempts are made at any architectural effect in the façades, which are, however, simple and appropriate. The town-hall of Winterthur, by Professor Semper, offers a striking exception in this respect. The design by Goss of a theatre for the city of Geneva is also an exception. This project is unmistakably inspired by that of the Grand Opera House of Paris, by Garnier. On a much smaller scale are to be recognized many of the salient features of that remarkable edifice, so superior to all others of its class in truthfulness of design, where every important part in plan is properly accentuated in elevation, and which, though not faultless, is yet much to be admired for its variety, and that richness of ornamentation so appropriate to such a monument.

That important problem, viz., the amelioration of dwellings for the laboring and industrial classes, has been almost entirely ignored at the

Centennial. This absence is especially to be remarked upon, so much attention having been paid to this subject, particularly since the Paris Exhibition of 1867, when the French Emperor received a special medal for his well-merited and successful efforts in this direction. Holland and Switzerland alone furnish projects of this class, and these are very incomplete and unsatisfactory. That such buildings can be made a practical success is proved by the report of the "Improved Industrial Dwelling Company" of London, which states that no less than 10,000 persons occupied dwellings under their control in January, 1876, while their available capital was then £1,000,000. To the untiring zeal displayed during the past fourteen years by Sir Sidney H. Waterlow, chairman of the association, is due in a great measure the success of this enterprise.

BUILDING-MATERIALS.

BY RICHARD M. HUNT.

The display of building-materials at the Centennial Exhibition was remarkable rather for extent and variety than for novelty. The great natural wealth of the United States was in this respect well represented. American labor-saving machinery, too, in building appliances compared most favorably with that of other nations. The scientific and artistic resources of European manufacturers, on the other hand, assured to their exhibits a very high standard.

In this brief review attention will be confined more particularly to the improved building-materials used in the construction of dwelling-houses and buildings. It might be well, however, to preface any remarks on this subject by alluding to some of the various natural products of this class in the Exhibition. A full and comprehensive report on their comparative merits may be found elsewhere.

The variety of woods was almost endless, nearly every climate and country being represented. Great ingenuity and taste were displayed in these exhibits; that made by Japan being especially thorough and complete in every detail, the various specimens being shown with and without the bark and leaves, and in sections crosswise and lengthwise, both polished and unpolished.

The exhibit of building-stone, though quite extensive, was less complete, excepting that made by the United States, which was exceedingly rich in granites, marbles, and sandstones of every texture and color.

Yellow, olive, and red sandstones from Ohio, New Brunswick, Maryland, New Jersey, and Lake Superior, offered an extensive col-

lection of freestones for building purposes. Those of Ohio and New Brunswick were remarkable for the dimensions of the blocks which can be obtained from the quarries, also for their excellent quality and even color. The facility for supplying stone from these quarries is so great that they are frequently used as more available than local freestone.

The granite quarries of the United States are only partially, but otherwise exceedingly well, represented by the BODWELL GRANITE COMPANY, *Rockland, Maine*, the MAINE RED GRANITE COMPANY, *Red Beach, Maine*, ST. JOHNSBURY GRANITE COMPANY, *Vermont*, ST. CLOUD GRANITE QUARRYING COMPANY, *St. Paul, Minnesota*,—the products of which are equal in workmanship and material to those of the famous Aberdeen and Dabbeattie quarries of Scotland. There are also some interesting samples from Maryland and from the Bay of Fundy, of excellent color and texture.

Among the best decorative marbles in merchantable dimension, the Dougherty marble, of Tennessee, and the Mexican onyx are the most remarkable,—the first for its texture and the large size of the blocks, the second for its great beauty, resembling the onyx marble of Algeria.

The exhibits of Maryland, Vermont, and Canada comprise marbles of almost every color.

The demand in this country for improved building-materials has been constantly increasing of late years, and has been supplied extensively by the European markets with cements, terra-cotta, and earthenware, also with granites, marbles, metal-work, etc., for decorative and monumental purposes, the quarries of this country supplying the great bulk of the stone, and our mills furnishing the iron and wood and the mass of material used in construction. One of the most noteworthy improvements connected with modern construction is the extensive use made of beton and concrete (a conglomeration of sand, pebbles, broken stones, and lime mixed with water). This method of construction was very generally employed by the ancient Romans, vestiges of whose monuments scattered throughout the Old World still remain to attest the superior quality of such work. Its just claims for strength and durability, obtained at a moderate cost, have been fully demonstrated in the various engineering works of the day, such as bridges, aqueducts, embankment and retaining-walls, sewers, cisterns, reservoirs, etc. In civil structures, particularly where economy was an important element, this system has also been used. Churches, dwellings, store-houses, and buildings of every class have been constructed entirely of this material, with the most satis-

factory results. Concrete and beton have been used to some extent in this country, but by no means so universally as in Europe. In civil constructions, with few exceptions, its use has been here mostly confined to foundation-work.

Our unequal and varying success with these materials does not agree with the uniform and satisfactory results obtained in Europe. This fact is partially due to a want of experience in handling the component parts, too much water being often used in mixing, and insufficient care also being taken to cleanse thoroughly the gravel and stone. With the experience gained by a more general use of these materials in this country, the same results will undoubtedly be attained. The great prevalence of this mode of construction has naturally led to noted improvements in the manufacture of limes and cements, the essential element in their composition.

The hydraulic lime of Teil, manufactured at Teil, France, by MESSRS. LAFARGE & CIE. and MESSRS. SOUILLIER & BRUNOT, is one of the strongest limes known. It owes its hydraulic property to the large percentage it contains of silicate of lime (66 per cent.). Convincing proof of the great superiority of this material is furnished by the satisfactory results obtained in the maritime work at Sully, Marseilles, Cherbourg, and other places, where Teil concrete blocks have been used in the construction of breakwaters, etc., and exposed for many years to the most severe test.

The English still retain their reputation for the manufacture of the highest standard of Portland cements, samples of which are exhibited by HOLLICK & Co., A. H. LAVERS, EASTWOOD, & Co., the WOULDHAM CEMENT COMPANY, and others. France also exhibits a superior article, manufactured by LONQUETY & CIE., *Boulogne*. The Portland cements manufactured in this country have not yet been sufficiently tested to form a definite opinion as to their merits. It is claimed, however, that an article equal to the best English manufacture is now being made in Chicago.

An exhibit of plaster of Paris from Colorado is quite equal, if not superior, in strength and whiteness to the best Eastern plasters.

The artificial stones exhibited have a certain resemblance in color and general appearance. Their qualities vary with the ingredients used in their manufacture, and their value as building-material depends greatly upon circumstances. It cannot be said, however, that there are many cases in which they are equal to good natural stone.

The Exhibition furnished an almost endless variety of bricks, both as regards quality and manufacture. The ordinary brick made in this country is not excelled by that of any other nation, and for color,

material, and finish, the face bricks of Philadelphia and Baltimore are unrivaled. The Dutch exhibit of this article is curious for variety of dimension and color, also for crude finish. The English, on the other hand, excel in their various exhibits of moulded blue and colored bricks.

The blue and metallic bricks manufactured by THOMAS PEAKE, WOOD & IVERY, JOSEPH HAMBLET, and others, are of especial value for pavements and ornamental work, their value being based principally on their resistance.

Enameled bricks, so useful in decoration and so proper for facings, especially where great cleanliness is a desideratum, were exhibited by MESSRS. MINTON and others, *England.* A very superior article was also furnished by the BRICK ENAMELING COMPANY, *Philadelphia.*

E. MULLER, *Paris*, exhibited hollow glazed and enameled bricks. Those glazed on one end are intended for the lining of outside walls as a protection against dampness, heat, and cold, and others glazed on both ends for partitions.

The manufacture of the ordinary hollow brick used in floor-arches, partitions, and floor-linings is no longer confined to a few countries in Europe, but is now well-nigh universal, specimens having been sent from Spain, Norway, Sweden, and from the Argentine Republic.

Attention may here be properly called to the exhibit of hollow bricks or blocks made by the NEW YORK FIREPROOF BUILDING COMPANY. These blocks are made of Teil lime, after models of blocks employed very generally and with marked success in France during several years past. They are of all sizes, and are especially suitable for partitions, arches, floors, ceilings, roofs, furring, etc. Their great strength combined with lightness, together with their fire- and waterproof qualities, places them among the most valuable improvements of the day.

In certain countries where stone was either of an inferior character or too expensive for general use, terra-cotta was naturally introduced. Many remarkable specimens of such work are to be seen in Northern Italy. Of late years much has been done in England to create a revival in terra-cotta architecture. Praiseworthy as such efforts are, it must be confessed that the results obtained are not as yet entirely satisfactory. It can hardly be claimed that any of their terra-cotta work compares favorably with stone-work in appearance. In this country, where stone of every color and texture abounds, scarce any attention thus far has been given to this subject; but, with the ever-increasing desire to produce novel architectural effects, it may be presumed that our attention will soon be directed towards terra-cotta architecture,—a

very appropriate style for certain structures. The terra-cotta mantelpiece exhibited by MESSRS. DOULTON & Co. surpassed all other exhibits in this class.

The English floor-tiles are noted for their general excellence and even quality, also for artistic design and beauty of color. An almost exhaustive exhibit of this article was offered by MESSRS. CRAVEN, DUNNILL, & Co., MAW & Co., MINTON, HOLLINS, & Co., and others. The tiles manufactured by MESSRS. HILEROY & BOCH, *Mettlach, Germany*, are not so bright in color, but much harder than the English tiles; their designs also being larger, fewer small tiles are introduced, and they are especially suitable for spacious areas, public places, etc., entire resistance to frost being also claimed for them. In roofing-tiles the New Jersey State Building offered a very creditable exhibit, manufactured by HENRY MAURER, *Perth Amboy, New Jersey*. It is to be hoped that sufficient encouragement will be given to this enterprising house to induce it to manufacture glazed tiles of different colors, an article used formerly with much effect in roof-decoration.

The roofing-tiles of the Japanese Building, in the Park, were remarkable for their light weight. The exterior surface had the appearance of being polished with black lead, an effect probably produced by burning in some substance, which apparently penetrated about a quarter of an inch. They were extremely well laid with mortar joints, the hips and ridges presenting a particularly fine appearance.

The exhibition of roofing-tiles, though large, offered no new features. It is, however, worthy of note, that tiles manufactured by MESSRS. MERRILL & EWERT, *Akron, Ohio*, have been recently substituted for imported English ones on some of our public buildings, on account of their superior non-absorbent qualities.

Terra-cotta tiles, so universally employed for centuries in Europe, have been almost entirely supplanted by slate for roofing, the closer joints of the latter insuring tighter work, and its lesser weight securing economy in roof-construction.

The use of slate as a roofing-material in this country, at first limited to the localities producing it, and to the seaports where it was brought from Wales and elsewhere, is now becoming extensive; and the demand is being fully supplied by the quarries of Maine, Vermont, New York, Pennsylvania, and Virginia. But few slates are now imported from Wales, although in quality the Welsh slate surpasses, in certain respects, the American product.

The roofing-slate exhibited by the PEN-YR-ORSEDD SLATE QUARRY COMPANY, *North Wales*, are unexcelled in quality and color.

The resources of the Atlantic States were well represented by the

following firms, who furnished excellent varieties in shape and in color (purple, red, and green): MAINE SLATE COMPANY, *Skowhegan, Maine;* CHAPMAN SLATE COMPANY, *Bethlehem, Pennsylvania;* LEHIGH SLATE COMPANY, *Slatington, Pennsylvania;* and the PEACH BOTTOM SLATE-MINING COMPANY, *Philadelphia, Pennsylvania;* from whose exhibits an excellent impression could be obtained of the materials, facilities for quarrying, polishing, sawing, and preparing slate for the market. The sheet-iron tiles used in Europe some ten years ago do not appear to have held their ground against older and tried systems of roofing. The GARRY ROOFING COMPANY, *Cleveland, Ohio*, exhibited one of the best methods of sheet-iron roofing. The joints are well made, both when plain and intersecting; it is easily laid, and without solder, and adequate allowance is made for expansion.

There were also various exhibits of composition roofings, composed of gravel, ashes, slag, tar, etc., unsuitable, however, for any other than temporary and inexpensive structures, where economy rather than durability is desired.

The leaders, or water-conductors, used on most of the Exhibition buildings are square instead of round, and are strongly to be recommended as offering greater resistance to the repeated strain of freezing and thawing. Their use, however, is by no means new.

The attention paid to the manufacture of the following articles, especially in England and the United States, has led to great improvements; but as their durability, cleanliness, and consequent healthiness depend so much on their use and abuse, their relative worth can only be determined after long trial. The English exhibit of earthenware for traps, drains, and kindred purposes, from the manufactories of HENRY DOULTON and others, was interesting for the variety of its products as well as its perfect finish. Very fine work of this description is also done at Chicago and other places in this country.

The pottery-ware for bath, water-closet, and wash-basin contrivances, as exhibited by JENNINGS, *London, England*, was very complete and extensive.

WEAVER & PENNOCK, *Philadelphia, Pennsylvania*, also offered a very fine exhibit in this line.

Copper-work of rare excellence was exhibited by H. STEIGER, *New York, N. Y.*, and C. A. BLESSING, *Philadelphia, Pennsylvania.*

The soapstone exhibit of the PHILADELPHIA SOAPSTONE WORKS was unexcelled.

The exhibits of iron- and metal-work for constructive and decorative purposes were numerous and satisfactory. That made by Belgium of rolled and riveted iron beams, from the FORGES DE LA PROVIDENCE,

I. J. PARIS, and others, was remarkable for variety of shapes, good workmanship, and low prices. Included in Belgium's exhibit was an excellent specimen of forged work by PROSPER SCHRYNER, *Brussels, Belgium.*

Another good example of similar work was exhibited by H. R. IVES, *Montreal, Canada.*

The Park Pavilion, designed by THOMAS JECKYEL, Esq., *London*, and executed by MESSRS. BARNARD, BISHOP, & BARNARDS, *Norwich, England*, was by far the most important piece of this kind of work in the Exhibition, and was most beautiful in design and workmanship.

The doors of the French Annex Building were very well made, and were particularly notable for their convex panels, introduced to secure great strength.

The iron-work of the Main Exhibition Building, executed by the PASSAIC ROLLING-MILLS, *Paterson, New Jersey*, offered a very fair specimen of American workmanship of this class.

Prominent among other national exhibits were those of CARNEGIE BROS. & CO., *Pittsburgh, Pennsylvania*, COOPER, HEWITT, & CO., *New York, N. Y.*, and the UNION IRON COMPANY, *Buffalo, New York.* Excellent specimens of rolled beams, varying from 50 feet to 80 feet in length, were among the products of the latter company.

The cast-iron work of J. B. & J. M. CORNELL, *New York, N. Y.*, showed great perfection in workmanship, moulding, casting, and fitting, but their ornamental work was wanting in characteristic design.

The exhibit of stable-fixtures, etc., made by JAMES L. JACKSON, *New York, N. Y.*, was to be commended for its extent, variety, appropriate and good work.

Roof-construction has undergone great changes within the last century, since the substitution of iron for wood. The French were among the first to make use of wrought-iron for this purpose, 1786–1790. The continual improvements made since have gradually led to great perfection. Railway stations, particularly European ones, offer fine examples of iron roofs, remarkable for their lightness and the skill displayed in the adjustment of their various parts. The French have been particularly successful in their artistic treatment of this material; the Bibliothèque Ste. Genèviève and the Bibliothèque Nationale of Paris, among other important works, furnish novel features both in construction and ornamentation characteristic of this material.

Fire-proof construction has been almost universally employed in the roofs of public buildings for years past, and daily its signal advantages are rendering its employment more general in private work. Already in many European cities iron is universally used for this pur-

pose. The increased expense of this material as compared to wood has, unfortunately, prevented its general introduction in this country. Many methods have been devised for rendering wooden roofs fire-proof. The exhibits in this class made by the NEW YORK FIRE-PROOF BUILDING COMPANY (already alluded to) were very thorough and complete, the result being obtained at a moderate cost.

The excessive cost of stone-work in the United States, limiting its use to ashlar, window-sills, and lintels, and nearly prohibiting its use for cornices, even of public buildings, has created a great demand for inexpensive work resembling stone. This demand was met by wood until outlawed by the authorities in our principal cities, then by zinc, galvanized iron, and copper ornamented by stamped zinc, spun brass, etc. Exceptionally, tinned copper has been used, and very rarely lead. The artisans working these sheet-metals have from the beginning displayed great ingenuity in producing work at small expense and proportionately durable, copying the traditional forms of stone-work to perfection. The galvanized-iron pavilion represents very fully the achievements of the trade in this country.

The tendency to return to the legitimate use of stone for cornices, limiting the use of sheet-metals to such portions of the roof as cresting, hips, gutter-linings, etc., is to be welcomed with satisfaction.

THE NETHERLANDS EXHIBIT OF PUBLIC WORKS.

BY GEORGE E. WARING, JR.

While the engineering works of other nations constitute relatively but a subordinate part of their claim for public respect, the engineering achievements of the Netherlands are of such magnitude, both actual and relative, and are so largely the basis of the great prosperity of the country, that it was quite natural that they should be made the most conspicuous feature of the Dutch display in the Exhibition.

In the most prominent position in the Dutch pavilion there was a large central tower or post from which five large wings radiated. On the sections of the post, and on both sides of the wings themselves, were well-executed maps illustrating some of the more important features of the railway and hydraulic engineering of the country. In the angles between these wings were models and plans in relief illustrating details of different works. Near by were other models, maps, public reports, and photographs, some of the more interesting of the latter being mounted in convenient swinging-frames.

In detail, this exhibit included the following in the order in which they appear:

1. Plans illustrating the construction of the William III. Locks, at the entrance to the North Holland Canal, opposite Amsterdam. This shows with special clearness the Dutch manner of forming foundations for heavy masonry by the use of piles.

2. The Kuilenburg bridge over the Lek. A drawing and a landscape picture illustrating the position and construction of the bridge, and an excellent *fac-simile* brass model showing one-half of the largest span of the bridge,—a span of 150 metres. The length of the whole bridge is 665 metres. The foundations required the use of over 15,000 piles and nearly 10,000 cubic metres of concrete. The under side of the span is about 12½ metres above the average summer level of the water. The amount of metal used in the whole bridge is about 5½ million kilogrammes. In view especially of the difficulties of the situation, this bridge may be regarded as one of the great engineering triumphs of the age.

3. The "New River" channel from Rotterdam to the North Sea. A map shows the former intricacy of the water-course, and indicates the dangers to which navigation was subject, owing to irregularities of current, the shifting of sand-bars, etc. The improvement includes a rectification of the channel and the formation of a secure harbor, protected by breakwaters running into the North Sea for a distance of about two kilometres. The great practical interest of this exhibit is connected with the formation of the breakwaters into the sea. These are shown in cross-section on a large scale, in plan and by excellent models of the entire work and of its parts. Not only do these plans and models help us to a better appreciation of the Dutch engineering, but they give every detail needed for the instruction of engineers who may be intrusted with such work in our own country. Indeed, so carefully are all of these details illustrated by drawings, and models and photographs, and so completely are their statistics described in the official report, that even the curious student who may have no special interest in engineering enterprises will find no difficulty in understanding them. The large plan in relief, illustrating this improvement, not only serves well its direct purpose, but enables one who knows Holland only from description to realize the natural character of the reclaimed portions of the country, the manner of cultivation, means of communication, distribution of population, etc. Among the photographs are many interesting ones taken at different stages of the work, so that we see clearly how its different parts were actually executed. One's idea of the cost of Dutch public works may be aided by the statement that the south jetty, or breakwater, cost 1550 florins per linear metre, or about $200 per linear foot.

4. A brass model of the outer gate of the great sluices of Flushing harbor.

5. The reclamation of Haarlem Lake. On this subject seven maps were exhibited,—six showing the gradual formation of the lake from the action of the water of the separated ponds of 1531 upon the silty soil, reaching finally, in 1806, an area of about 43,000 acres, and stretching almost to the cities of Amsterdam, Haarlem, and Leyden, which it frequently threatened with destruction. The seventh map shows the whole tract protected by an enormous dike, and surrounded by a large navigable canal, its smooth floor divided by cross-canals and roadways into a populous cultivated area dotted over with houses and barns and containing two prosperous villages. Sections are given which show the construction of the dike and canal at different points, and suitable drawings show not only the construction of the engines and pumps by which the drainage was effected and by which it is maintained, but illustrate at the same time the almost universal practice of founding the heaviest structures on piles.

6. The steel swing-bridge at Dordrecht, with its somewhat original method of pivoting and support.

7. The denudation and protection of the sea-coast of North Holland. Here were shown the construction of the great "Hondsbosch" and "Petten" sea-dikes, which have a length of 5½ kilometres. Both dikes are protected for nearly their whole length by a facing of basalt. The stone face of the Hondsbosch dike alone measures 13 hectares (or about 32 acres). These and the Helder dike, with the illustrations of the waste and subsequent protection of the coast at Egmont, constitute in themselves a tolerably complete school of sea-embankment. In the exhibit, and in the accompanying documents, there is to be found really all that has been learned by the centuries of active experience in connection with these enormous works, and the disastrous sea-action against which they are to serve as a protection. In the case of the town of Egmont, the present sea-line lies along the very heart of the town as it existed two hundred years ago. More than half of the ancient city has been washed into the sea. The plans of the city in 1686 and 1718 show a strong fascine-made dike, and a large church and plaza. The map of 1875 shows that all these have been swept into the sea, a massive new dike protecting, it is hoped forever, the town, which has crept back farther from the shore.

8. The canal from Amsterdam to the North Sea. This is in some respects the largest work of its kind in Holland. It includes the construction of a broad and well-protected harbor, stretching three-quarters of a mile into the North Sea; an excavation through the

high sand-dunes along the coast; and a canal fully sufficient for the largest commerce,—reaching from the sea for a length of over sixteen miles to the city of Amsterdam. This work, which is now nearly completed, has included the draining of the large arm of the Zuyder-Zee, known as the Ij, whereby 5000 hectares have been reclaimed. More than half of this has already been sold for an average of 2000 guilders per hectare (about $160 per acre), and is now in cultivation. The maps and plans show the condition when completed; the condition in December, 1874; the location and form of the harbor; a cross-section of the breakwater; a section of the dikes of the canal; a plan of the locks near the coast; of the locks near the Zuyder-Zee (with ten chambers for vessels of different sizes); of the iron lock-gates; and sections of the two largest locks.

This improvement was also illustrated by a relief-map of the whole country between Amsterdam and the North Sea, indicating the depths of its polders, the subdivision of the land, etc.

9. The dams across the Schelde and the Sloe. These are railway dams on the line from Flushing to Bergen. They are chiefly remarkable for their great size and depth, and the necessity for completing each one within a single season, so far as to protect it against the storms of the succeeding winter. The drawings leave nothing to be desired in the way of executive detail.

10. The harbor of Haarlingen. Here were five maps, and several cross-sections, showing the forms of the dikes and docks, the material of which they are constructed, and especially the facing of basalt blocks, by which they are protected against the action of the waves. Models were also shown of the piers, which gave every detail of construction. The most interesting item of this exhibit is a submerged dam built in the Zuyder-Zee, some distance from the shore, for the purpose of guiding the tidal current in such a way as to prevent the deposit of silt in the channel leading from Haarlingen to the ocean. This dam, founded on fascine mattresses 20 metres wide, is covered and filled with heavy stone, and protected by two rows of oak-piles. It rises but little above low-water mark.

11. A crane-bridge over the Linge,—curious rather than important.

12. A swing railway bridge over the North Holland Canal. This is a good specimen of a short, secure, and easily-worked swing-bridge.

13. A picture and detailed drawings of the great bridge over the Holandsch-Diep and its dry-dock. This work was executed between 1868 and 1871. The width between the dikes at high-water mark is over 2½ kilometres. The minimum rise and fall of tide is two metres.

The bridge consists of dams, built with fascine mattresses, and a fixed bridge of 14 spans of 100 metres each in the clear. Ten of the piers are founded on piles, and three were constructed by the sinking of caissons with air-pumps. The solid bottom was in one case 60 feet below low water, and lay under more than 20 feet of peat. The caissons used were about 50 by 22 feet. Owing to the danger from storms during construction, which made scaffolding impracticable, the trusses were erected on the shore, and were carried on pontoons at flood-tide, and placed over their positions. As the pontoons fell with the ebb the trusses rested in their proper positions on the piers. The cost of this work, aside from the dams or embankments, was over 4½ millions of guilders, and two-thirds of this cost was consumed by work done below low-water mark.

14. Two maps of North Holland, one representing its condition in 1575, and the other its condition in 1875 (assuming the draining of the Ij to be complete). The first shows the country to be occupied almost entirely by water, separated by narrow strips of land, which was of the most silty and unstable character, constantly yielding not only to the inroads of the sea, but almost equally to the movement of the water of the large lakes by which the country was so largely occupied. The latter shows the complete removal of nearly all of these bodies of water, the intersection of the province in every direction by canals and railroads, and the universal establishment of solid and well-cultivated agricultural land, dotted at short intervals, in every direction, with the sites of prosperous cities and towns and villages. These maps show, indeed, the formation of a populous and prosperous country, where three hundred years ago the hardy and industrious people were confined to the smallest area of unpromising land, and constantly contending against the most serious natural difficulties.

15. Blanken's automatic sluice-gates, shown by well-constructed models, represent an ingenious method for the opening and closing of such gates against a pressure of high water by hydraulic force. Where the indicated conditions exist, the adoption of this system is worthy of consideration. Incidentally, this model gives a very good idea of the forest of piles upon which all public works in the silty parts of Holland have to be constructed; the cost for foundation being always inordinately large, and constituting an element of real grandeur in the work,—an element which, in the finished condition, is hidden from observation.

16. The bridge at Bommel, shown in detail, and by a large perspective drawing, is quite similar to the one over the Hollandsch-Diep.

Its main truss, however, is higher, there being room under it for the passage of ordinary river steamers.

17. Fynje's steam-pump, which is immersed in the water that it is charged with removing, is a very large, simple, double-acting pump, whose enormous valves give it a very large water-way, and reduce to a minimum the resistance chargeable to friction and to a disturbance of the flow. Its fitness for its work has been tested by ample experience. The advantages that it offers for the draining of polders, and all work where large volumes of water have to be lifted to slight elevations, has led to its wide introduction in Holland, and entitle it to high consideration. It consumes but $1\frac{8}{10}$ kilogrammes of coal per effective horse-power per hour.

18. There was an excellent illustration of the methods used in establishing the foundations of the railroad bridge over the Maas at Rotterdam, by the introduction of large iron caissons, sunk with compressed air to the hard ground beneath the mud. These caissons are sunk by the weight of masonry built upon them, and are thus gradually depressed to the hard bottom underneath the mud. When finally in position they are filled with concrete.

19. A model was shown of the ordinary lever draw-bridge, in universal use throughout the country, for passing foot-passengers and vehicles over canals.

20. In the illustrations of the water-works at the Hague—where water of the sand-dunes is collected by canals and filtered,—the interesting feature is the elevated reservoir (which serves the purpose of a stand-pipe) at the top of a tall tower of masonry. An iron tank containing 1000 cubic metres stores fully the contents of an ordinary stand-pipe, and all at a high head. The rising main is only so large as is needed to supply this and to transmit the pressure to the pipes in the town. In the event of a cessation of the supply the stand-pipe head remains sufficient much longer than under the usual system.

21. The topographical maps, ordinance maps, etc., were all well executed and highly creditable.

22. Accompanying, and illustrating the exhibit, was an interesting series of photographs, showing the different stages of various important railroad and hydraulic works, so taken as to give the clearest idea of the exact manner of executing them; for example, in connection with the construction of the new river from Rotterdam to the sea, by the means of sunken mattresses, the photographs show the different preliminary processes, and the final suspension of the ballasted mattress over its position, attached to vessels by which it is surrounded, and from which the ballast has been supplied. When the tide is at

a stand-still the supporting ropes are cut simultaneously, and the mattress sinks between its guiding-piles.

23. The private exhibit of Mr. Jacob Paulus, Amersfoordt, of a model of the bottom of the southern part of the Zuyder-Zee, with soundings and indications of the underlying soil, etc., as it illustrates the project for the drainage of this immense sea, which is shown in one of the public charts, and is fully described in accompanying documents, deserves mention in this connection. This project contemplates the reclamation of over 480,000 acres of land,—the total of all previous reclamations in the Netherlands being over 293,000 acres. Its estimated cost, not including interest on loans, is 123,000,000 guilders (about $50,000,000).

THE FRENCH ENGINEERING SECTION.

BY GEORGE E. WARING, JR.

The engineering department of the French Government—"*Ponts et Chaussées*"—made one of the most notable exhibits of its class at the Centennial gathering.

This exhibit was displayed in, and indeed it included, a well-designed and appropriate building, of iron and colored bricks, near the northeasternmost entrance of the grounds. The building, designed by M. de Dartein, Engineer of the "Ponts et Chaussées," and Professor of Architecture in the École Polytechnique, consisted of a single large hall with an architectural vestibule flanked by small offices. The advantage of adapting the size and arrangement of an exhibition building to the objects which it is to display was well evidenced by the completeness with which every model and plan was shown, and by the successful utilizing of all space not needed for the somewhat restricted public which is attracted by engineering subjects.

As a necessity arising from the intermixture of models and plans, and of the variation in scale among the different objects, there was more or less incongruity of arrangement. Had the models and plans been prepared expressly for the occasion, this slight difficulty might have been avoided. On the other hand, no collection made with a single view to exhibition could have been so complete, nor could it have had so great a technical instructive value as this, in which actual working plans and original models were shown in profusion.

It constituted, on the whole, an admirably complete index to the engineering practice and system of France, where the visitor was enabled to study principles and processes in the most easy and effective way. For those who really cared to study detail, the capital

monograph (*Notices sur les Modèles, Cartes, et Dessins, relatifs aux Travaux des Ponts et Chaussées et des Mines, réunis par les soins du Ministère des Travaux Publics*) gave every facility and enlightenment. Commendation is due not only to the department and its chief, but notably to M. Lavoinne, the engineer intrusted with the erection of the imported building and the installation of the collective exhibit.

The exhibit was especially complete in the items of roads, railways, interior navigation, maritime works, light-houses and beacons, and public water-works.

It would be impossible in a brief report even to catalogue the different objects, and it is almost unfair to make invidious selections. The examples selected for this report are chosen not because they are the most conspicuously interesting, only as the most easily described in few words.

Among the models was one of four piers and three arches of the railway bridge over the Aulne,—of which the parapet is about 190 feet above the foundation rock, and where, as it crosses a channel used by seagoing vessels, the system of superposed arches could not be adopted. The result is bold and elegant.

The viaduct bridge at Point-du-Jour, below Paris, built for the *Chemin de fer de Ceinture*, was shown in three models,—1, a model of the whole structure; 2, a model of an arch of the approach; 3, a model of an arch of the bridge proper. The whole structure here represented is more than a mile in length, with a roadway and foot-path, and (at a higher level) a railway. The roadway is 44 feet above the foundations of the piers, and the railway is 30 feet above this.

The iron viaduct over the Bouble was shown by well-drawn plans. This noteworthy structure consists of 6 trusses, with a span of 164 feet each, carrying a railway 200 feet above the water-level, and supported by 5 trestle-work piers of iron, having a height of from 140 feet to 188 feet above the masonry foundations.

A large sheet of drawings showed the elevations, plan, and details of the new station, in Paris, of the Orleans Railway. This station, which now extends from the Boulevard de l'Hôpital to the Quai d'Austerlitz, covers about 25 acres. The architectural effect is grand and appropriate, and all of the dispositions for arriving and departing passengers and freight are excellent and well studied. The main roof, which covers eight tracks and two platforms, measures 169 feet by 918 feet. The entire work of construction, involving the removal of old work and the building of new,—involving the necessity of starting foundations at a depth of from 25 feet to 35 feet below the surface of the ground,—was carried on without interruption to traffic. In exca-

vating for the foundations, which have a total length of nearly a mile and a half, constant precautions were necessary to exclude the water of the Seine. The entire cost, including the purchase of new land, was 18,000,000 francs.

No element of this display of engineering works was more interesting than the model of automatic or self-adjusting lever for raising and lowering the flow-line of rivers, in slack-water navigation. This is the invention of M. Desfontaines, Engineer-in-Chief of the canalization of the Marne. The gates are of iron, moving on horizontal axes, and capable of raising the water-line between 3 feet and 4 feet above the level of the fixed dam. Their action is entirely automatic. By means of a pressure of the water above the dam against their lower wings their upper wings are raised to and held at any desired height,—regulated by the amount of water admitted to the section of the iron drum in which the lower wing moves, and by the respective forces of the water admitted in front of or behind the wing. In like manner, when the gates have been standing at their full height, they may be lowered either partly or entirely. Gates established under this system in 1858 are still in satisfactory use, and the system is worthy of careful study by engineers charged with canalization work. The following, concerning the history of this invention, is translated from the descriptive Catalogue: "In presenting the *Système Desfontaines* officially to the Americans, it is difficult not to add some historical information to the notice concerning it. . . . From immemorial time, in Holland, irrigation canals have been closed with gates having unequal wings. . . . The idea probably passed thence to America, for it there existed in 1818 on the Lehigh,—applied no longer in the form of gates with vertical axes, but under the form of gates or large panels of wood-work with horizontal axes. Described in a few lines in the work of M. Michel Chevalier (1843), and recommended by the late M. Mary, the system of dams used on the Lehigh was executed in France, on the Upper Marne by Messrs. Desfontaines and Fleur Saint-Denis. The work was in good hands; the result was, however, unsatisfactory. But this trial left in the inventive mind of M. Desfontaines a germ which bore fruit, and we send back, with some pride, to the other side of the Atlantic, the American dam Frenchified (*Francisé*)."

The improvement of the Seine, from Rouen to Havre, was well shown in plan and in profile. This work has been executed since 1848, and has so far secured a good depth of water at all times, so that the extra charge of one-half per cent. for marine insurance which was added in the case of sea-vessels going to Rouen, has been removed;

—the rate being now the same as to Havre. This improvement has been effected by the use of dikes built parallel to the course of the river, reducing the width of the current to about 1000 to 1500 feet. The dikes are built of blocks taken from the chalky shores of the river. The work will have cost when completed 23,500,000 francs. Incidentally there have been reclaimed about 25,000 acres of alluvial land, much of which is now in good grass. These lands as they become consolidated are returned to the riparian owners on payment of one-half their value. The rebate on the cost of the work arising from this source will probably reach the sum of 5,000,000 francs.

Drawings were exhibited giving general views and details of the harbors of Havre, Bordeaux, Brest, and Saint-Nazaire; also of the gates of the harbor of the latter port. Concerning the entrance to the port of Bayonne, useful and interesting information is given as to the current-guiding rows of piles, which are used to prevent the closing of the mouth of the harbor by sand and gravel, drifting from the shore to the mouth under the action of heavy storms. The first construction was of wooden piles. In time these were destroyed at low-water mark by the boring of the teredo. The wooden piles were placed quite near together (in a single row on each side of the channel), only sufficient space being left between them to allow the water to flow freely. The piles were about 1 foot in diameter, and the open spaces were about 2 feet each. These have now been replaced by rows of cast-iron tubes 6½ feet in diameter, with intervening spaces of 10 feet. The tubes are sunk with compressed air, and are filled with concrete. The details of the work are well explained; the action of the lateral flow of the tide through the intervening spaces in preventing the formation of sand-bars is shown to be quite equal to the expectation of the engineers who planned the work.

The harbor works of Marseilles were shown by models and drawings of (1) the harbor proper, which has been extended from an area of 71 acres in 1844 to 325 acres in 1876, all conquered from the sea, and which is adapted to the use of the largest ships; (2) spacious dry-docks; (3) the draw-bridge across the Joliette. The cost of the work when completed will reach 70,000,000 francs. It has included some of the finest breakwater-work in the world.

The St. Louis Canal, by which the deep water of the Rhone is connected with the Gulf of Foz, avoiding the bar which exists at the mouth of the river, was shown by drawings in different scales. The canal proper is more than 2 miles long, nearly 100 feet wide at the bottom, and 200 feet wide at the level of low tide. The depth is nearly 20 feet below low water-mark. It is finished with a large

harbor near the sluice-gates which connect it with the Rhone, and another at its outer end. The details of the work are very interesting and instructive.

One of the most conspicuous sections of the exhibit was that devoted to light-houses and beacons, many of the more important of which were shown by large models and colored drawings, full of interest for those charged with the execution of such work.

The large map of France opposite the entrance door showed the location of the light-houses along the whole coast, with white circles, —always overlapping each other,—giving the range of each.

Much space was also given to the subject of public water-works, and the plans of these, accompanied by the descriptions contained in the *Notices*, constituted a very valuable source of information.

The *Notices* also gives a very complete account of the "École Nationale des Ponts et Chaussées," and of the "École Nationale des Mines."

Taken as a whole, this exhibit and its carefully-prepared book of explanations cannot be too highly commended.

ARCHITECTURE AND ENGINEERING.

BY SIR JOHN HAWKSHAW.

(Extracts from the Report to the British Commission.)

In the capacity of one of the Judges my functions at the Exhibition were confined to Civil Engineering and Public Works, and in the division of labor agreed to among the Judges of that class it fell to my lot to report on so much of it as related to the United States and to Great Britain, the works of other countries being allotted to other Judges.

Civil Engineering and Public Works could not without great labor and expense be fully illustrated in any Exhibition, and engineers who have to deal with such works have usually their time too fully occupied to say much about them either during their progress or afterwards. Partly perhaps from these causes Great Britain, though not unduly represented in the Exhibition in some other departments, was, as it regards Civil Engineering and Public Works, hardly represented at all. Some other countries, Holland, for example, owing probably to the public works of that country being more under the control and supervision of the Government, were at its instance much more amply represented.

The superintendence of engineering works in the United States is of a more mixed character; while some of the largest and most im-

portant works in that country are performed by civil engineers, there are many works on the coasts and in its rivers which are executed by the corps of engineers of the United States army. This appropriation of engineering work to military men arises probably from the circumstance that, though the number of rank and file in the United States army is small, there is a desire to maintain a large staff of officers, many of whom are thus employed. From this circumstance probably a more copious illustration of engineering works was exhibited by the United States Government. The civil engineers of that country in some cases sent to the Exhibition no account of some very important works, but after my labors at the Exhibition had ceased, I took the opportunity of visiting and inspecting some of those works, and the remarks which follow therefore must be taken in some cases to illustrate what I observed on the spot, or on which I acquired information in other ways, as well as what I examined in the Exhibition.

RIVERS.

Under this head the operations for the removal of the reef at Hallett's Point, Hell-Gate, New York, are remarkable for originality and boldness. The reef projects into the channel at Hell-Gate about 300 feet. The depth over it for the distance of 270 feet from the shore is at low water less than 12 feet. The channel there being narrow and crooked, the object of this improvement is to widen and straighten it by securing a minimum depth of 26 feet of water over the reef. The work was commenced in July, 1869, by building a coffer-dam between high- and low-water marks. In October following the excavation of the shaft was begun. From the bottom of the shaft 10 tunnels were driven under the river in radial lines, and were extended until a depth of water upon the reef of 26 feet at low tide was reached, the roof of the excavation being kept nearly parallel to the bed of the river and about 10 feet below it. The main tunnels are about 14 feet in width, varying from 10 to 20 feet in height, and averaging about 270 feet in length. They are connected with each other at intervals of 30 feet by means of cross tunnels or galleries of about the same height and width. Between the tunnels and galleries large columns of solid rock were left to support the roof of the excavation or bed of the river; these large columns were afterwards cut through by other tunnels and galleries, and finally 173 piers or columns were formed, averaging about 10 feet each in thickness. The entire roof thus undermined covered an area of three acres. The aggregate length of tunnels and galleries driven under the bed of the river was 7425 feet. From the excavation about 47,460 cubic yards of rock were removed by drill-

ing and blasting, an operation which required 208,174 lineal feet of drill-holes, of which 90,107 feet were drilled by hand and 118,067 feet by various kinds of machine-drills, viz., the Burleigh, Diamond, Rand, Winchester, Wood, Ingersoll, and Waring drills, worked by compressed air.

The usual method of driving a tunnel or gallery was as follows: the face of the rock was pierced obliquely with as many drill-holes from 3 to 4 feet in depth as were deemed necessary; the charges were then prepared by placing the explosive material in water-tight paper cartridges from 8 to 12 inches long and containing from 8 to 12 ounces of explosive mixture; into each of these cartridges a copper cap containing mercury fulminate fastened to the end of a piece of safety-fuse, generally about 5 feet in length, was inserted. The cartridge was then pushed to the bottom of the hole, which was filled with water; the ends of the fuses hanging from the drill-holes were then ignited. In the preliminary operation of forming the tunnels and galleries the following quantities of explosives were used: blasting-powder 24,431 pounds, nitro-glycerin 26,471 pounds, giant-powder 1932 pounds, mica-powder 600 pounds, Vulcan-powder 4017 pounds, rend rock 1500 pounds. In exploding these compounds 63,756 exploders and 331,516 feet of Bickford's safety-fuse were used. In all about 75,000 blasts were fired.

A good model showing the tunnels and galleries and the pillars left to support the roof was sent to the Exhibition. When I visited the work at the beginning of August, 1876, holes had already been drilled in the pillars and roof to receive the explosives for the final explosion. These were intended to be charged with nitro-glycerin cartridges to be connected by wires with a battery to be placed at sufficient distance. It was intended before making the discharge to fill all the tunnels and galleries with water. The explosion took place a few weeks after I left. To complete the work the débris will have to be removed.

It will be interesting to learn, when the work has been completed, what has been the total cost to compare with the probable cost of reducing the shoal by the more usual method of submarine blasting. The excavation of another reef in the channel, the Flood Rock, has already been commenced upon the same principle as applied to Hallett's Point. While on this subject, it may be useful here to mention a machine used in the United States in removing reefs and rocks under water by blasting from the surface, and which is described as follows:

Steam Drilling-Scow.—The machine consists of two parts, a large

float or scow having a well-hole in it of a diameter of 32 feet. It is built very heavy and strong, and is provided with an overhang or guard around it faced with iron, and has proved itself up to this time capable of withstanding violent collisions with other vessels.

Besides affording this security it serves also to transport the caisson or dome from place to place, and is a working platform from which the drilling-engines are operated. The caisson or dome is a hemisphere of the diameter of 30 feet, composed of a strong iron frame covered with boiler-iron. The dome is open at bottom and at top, and is provided at the bottom with legs to support and level it, which are arranged to let go altogether after the dome is lowered.

The hemispherical shape of the caisson is favorable to stability. The caisson or dome is simply a frame-work affording a fixed support to 21 drill-tubes, through which the drills operate. The dome is connected with the scow by four chains communicating with four hoisting-engines, by which it is lowered or raised. A frame-work is built upon the scow around the well-hole to support the carriage holding the drill-engines, which by these means may be placed directly over the drill-tubes. The engines simply raise the drill-rods, and allow them to fall by their weight upon the rock, the vertical play being 18 inches; the drill and drill-rods together are about 10 feet long, and weigh from 600 to 700 pounds. The cutting edges are in the form of a cross, and are 5½ inches long.

The scow, having the dome swung by chains, is first anchored over the rock to be operated upon, so that the bow and aft moorings pull against the direct currents of the ebb- and flood-tides, but as these may vary somewhat in direction from one tide to another, as well as during the course of the same tide, it becomes necessary, in order to steady the scow, to have side anchors also. The diver descends to ascertain whether the location is well suited to placing the dome on the bottom, and if not, to select a better. The required change in the position of the scow is made by lengthening and shortening the mooring-chains with capstans, which are arranged to be worked at will with steam- or man-power. The dome is then lowered, and when it touches or approaches near the bottom the legs are let go, and, being held by self-acting cams, support the weight of the dome. The chains are now unslung from the dome, which is thereby without connection with the scow. The diver descends to ascertain which of the drill-tubes it is necessary to use to break up the rock within the dome, and how the surface offers itself to each particular drill. The drill-rods being introduced within the drill-tubes, which is easily effected during the most violent currents, a rope or other flexible connection is now made between the

top of the drill-rod and the piston-rod of the drilling-engines. A flexible connection is necessary to the act of drilling, as in this machine, the dome remaining fixed upon the bottom in one position, while the scow holding the drill-engines swings for short distances from changes in the directions and strength of the currents, no rigid connection between the engine and drills would be practicable. The length of the rope attachment is regulated by a feed-gear for the rise and fall of the tides and continual changes of water-level.

The drilling being completed, preparations are made for charging the holes with nitro-glycerin. The chains are hooked on the dome, which is then raised from the bottom, and the scow swung off from the spot to a safe distance without casting loose the moorings. This distance will depend upon the proposed amount of charge of nitro-glycerin, and will vary from 175 to 350 feet. The nitro-glycerin in tin cases of different lengths, to suit the varying depths of the drill-holes, is carried to the spot upon a small scow, from which the diver descends to the first hole to be charged. He is guided to this by a line. Withdrawing the plug, he introduces into the hole the tin cartridge, which has been filled by the men on the scow and passed down to him. Each cartridge is attached before it is sent down to the wires. The diver then passes on to the second hole, guided by the plug-line which connects the stoppers of the adjacent holes, and in this way the whole circuit of holes is visited and charged. The leading wires are connected with the battery, when the small scow has been withdrawn, and the explosion is made.

To break up the rock thoroughly, the drill-holes should be from 6 to 8 feet apart, of the size of 5½ inches at the top, and charged with amounts varying with the depths of hole, which will average between 50 and 60 pounds for each, and the depth to which the drill-hole should reach below the level to which it was desired to break the rock is about 4 feet.

After the rock broken by the explosion covers the greater part of the reef, its removal is commenced. This is effected by means of a steam-grapple.

By this machine Way's Reef at Hell-Gate, and Cerentie's Reef in the East River, have been removed to the depths of 26 and 25½ feet respectively. It has also operated upon Diamond Reef, East River, and Frying-pan and Pot Rock in Hell-Gate, and removed portions of those reefs. A channel has been cut by the same machine through a reef in the Harlem River.

The Mississippi.—Another very interesting engineering work is now in progress with a view to improve the entrance to the Mississippi,

The waters of that river, estimated to amount to 1,280,000 cubic feet per second, find their way through the Delta into the Gulf of Mexico mainly through three channels or passes, viz., the Southwest Pass, the South Pass, and the Pass a l'Outre; the centre or South Pass hitherto has not been used for commerce; and, though it is the most direct passage, yet before the works began not more than about one-tenth of the waters of the Mississippi found their way through it to sea. The object of the works, which are now in rapid progress, is to improve this outlet, which in its original state at high tide had not more than 8 feet of water on its bar, and to secure if possible everywhere along it a depth of 20 to 26 feet. With this object, jetties 1000 feet apart, formed of mattresses covered with stone, are being constructed on each side of the channel, and the result of this work is awaited with great interest, for if successful it will be of vast importance to the traffic of that great river, and will produce changes in the direction of traffic to and from this vast continent difficult at present to estimate.

HARBORS.

The magnitude of the lakes and rivers, of sheltered bays, and arms of the sea, have spared the United States the necessity of constructing deep-sea artificial harbors like those which have in some cases in England, as at Holyhead and Portland, for instance, involved so much expenditure. But some of the American lakes are like inland seas, and sometimes call for works of magnitude such as the Harbor of Refuge now constructing on Lake Huron, where the breakwater will be 7000 feet long, and will inclose an area of 320 acres of 12-feet water. The method of constructing this and other breakwaters, much used in the country, is called crib-work. It consists in forming boxes or frames of timber of the width of the structure required, and of convenient lengths, and divided into compartments. The frames are floated to their place, then sunk, and afterwards filled with stone. Where necessary, in very exposed situations they are protected outside by stone or *pierre perdu.*

Of the models of similar works exhibited may be mentioned—details of crib-work used in the breakwater, Oswego harbor, Lake Ontario, New York; model of crib-work used in the construction of United States breakwater at Dunkirk, New York, Lake Erie.

LIGHT-HOUSES.

Many models of the structures, varying in material and mode of construction, were exhibited by the Government of the United States, with samples also of beautifully-constructed lenses of each class.

One of the best specimens of light-houses is that on the Meriolo Ledge, at the entrance to Boston Bay, visible 16 miles, with a second order lens, and furnished with fog-bell struck by machinery. This light-house stands in 12 feet of water at high tide, and is built of granite. Its base for a considerable height is solid, the lower courses of stone being bonded by a system of dovetailing, differing from that of the Eddystone or Bell Rock light-houses, but sufficiently effective for its situation.

Models of other forms of light-houses were exhibited, of which I may mention—

The stone light-house built on the Spectacle Reef, Lake Michigan, visible 16¾ miles, alternate red and white light, furnished with a 10-inch steam-whistle.

The iron-pile light-house on Alligator Reef, visible 18 miles, lens of first order.

The iron light-house on Coffins Patch, Sambroro Shoal, Florida Reef, lens of first order.

The iron screw-pile light-house on Brandywine Shoal, Delaware Bay, lens of third order, furnished with fog-signal bell.

The light-house, an iron tower 83 feet high, on the north pier of Chicago harbor, visible 16 miles, lens third order.

The vast extent of coast required to be lighted in the United States, which, including ocean, bay, lake, and river, without including the Pacific coast, amounts to more than 5000 miles, requires numerous lights, and the number of light-houses under the charge of the Light-house Board of the United States, including 36 on the Pacific coast, amounted in 1875 to 639. The number of light-ships was 23.

BRIDGES.

The magnitude of the rivers and the skill and boldness of the engineers have led to some remarkable specimens of bridge-building in the United States.

The well-known Suspension Bridge, 800 feet in span, erected over the river St. Lawrence some years ago, is being far surpassed by a suspension bridge now building over the East River, to connect New York and Brooklyn. Over a whole length of 3455 feet a bridge will be suspended in three main openings. The central span will be 1595 feet from centre to centre of tower, and the side spans, measuring from the centre of tower to the face of the anchor walls, will each be 930 feet. The roadway which the bridge is designed to carry will pass the towers at an elevation of 119 feet, and in the centre of the main span the elevation in the clear will be 140 feet above low water. The sus-

pended superstructure will consist of an iron framing, 85 feet in width, suspended from four main cables by wire ropes attached to iron floor-beams placed 7 feet 6 inches apart. The flooring is further to be divided into five spaces by six lines of iron trusses, of which the two centre trusses have a depth of 12 feet, and the others of 8 feet. The outer spaces have a width in the clear between the trusses of 18 feet, and each will accommodate two lines of iron tramways for ordinary street traffic. The next two spans, 13 feet 2 inches wide, will be provided with iron rails for running two passenger trains to be worked by a wire rope. The bridge is to be supported by four main cables, two outer ones and two near the middle of the flooring. The cables, of which a specimen was in the Exhibition, will be 16 inches in diameter, composed of galvanized tempered cast-steel wire, No. 6 gauge, having a strength of 160,000 pounds per square inch of section. The cables are to be aided by a system of 104 stays in each quarter, which are together assumed to be capable of upholding the superstructure of the main span, the aggregate weight of which, inclusive of cables, will be 5000 tons.

Another illustration of bridge-building on a grand scale is the Illinois and St. Louis Steel Arched Bridge, spanning the Mississippi at St. Louis,—a work remarkable for boldness of design and for originality in the mode of construction. This bridge has three main arches of large size. The central arch has a span of 520 feet, with a versed sine of 47 feet; and two arches, one on each side the central arch, have spans of 515 feet. Each of the three arches consists of four ribs about 12 feet deep, the top and bottom of each rib being steel cylinders, 18 inches in diameter, 2 inches thick at the skew-back, and 7/8 of an inch thick at the soffit. These are connected and braced together also by cylindrical tubes. The bridge carries a roadway on the top and a double line of railway beneath. The segments of the ribs as the erection advanced were supported by overhead guys passing over temporary towers erected on each pier and abutment, so that all scaffolding, centering, or supports from below were dispensed with.

The Raritan Bay Swing or Pivot Bridge, of which a model was exhibited, is a good illustration of a large bridge of another class. The movable part of the bridge is 472 feet in length, leaving, when the bridge is swung open, clear waterways on each side of 220 feet.

The largest iron truss bridge at present in use in the United States seems to be the Newport and Cincinnati Bridge, the channel span of which is 420 feet, but larger bridges of this class are already projected. One proposed to be built over the Hudson River at Poughkeepsie, New York, will have five spans each of 525 feet.

Some years ago a stone arch having a span of 220 feet and a versed sine of 56¼ feet was built on the Washington Aqueduct, and on the same aqueduct an iron bridge was built 200 feet in span with a versed sine of 26 feet, in which the segmental ribs which form the arch consist of iron pipes 4 feet in internal diameter, through which the water flows that supplies the city of Washington. The bridge so built carries a roadway, an ingenious device, which makes water-pipes serve two important purposes, neither of which interferes with the other.

I am unable within the limits of this report to do more than to illustrate by a few prominent specimens the magnitude and importance of the engineering works of the United States. The Girard Avenue Bridge, across the Schuylkill, at Philadelphia, is a fine structure, equal in size to the largest bridge across the Thames. The Croton Aqueduct for supplying New York with water is worthy to be compared with those of ancient Rome, and the tunnel driven under Lake Michigan at Chicago to draw water from the lake free from the pollution of the shore for the supply of that city is another work worthy of mention.

The Southwark Bridge, across the Thames in England, the Tubular Bridge, across the Menai Straits, and the Saltash Bridge, spanning the Tamar, at Plymouth, were in their day the largest iron bridges then constructed. So late as 1862 no iron girder or truss bridge in the United States probably had a larger span than 200 feet. The great advance in the size of structures that has since been made will appear from the few specimens of bridge-building which I have given.

Mere size, however, is not of itself indicative of science or skill, which in every work can only be measured by a just appreciation of the end aimed at, of the difficulties to be overcome, and of the ability displayed in surmounting the one and in securing the other.

From the magnitude and number of the public works in the United States, however, other lessons may be learned than those which tell only of the science and skill of its engineers. From what I have seen they possess enough of both to fit them for the accomplishment of any works they are likely to undertake.

The 70,000 miles of railway already constructed, the ramification of the electric telegraph, and its application to uses more extended and varied even than in our own country, the crowd of steamboats wherever navigation is possible and public convenience can be promoted, the building of cities like Chicago, which, after the great fire, in four or five years has arisen out of its ashes a more beautiful city

than before,—all these tell of the increase of wealth, and speak still more strongly of the public and patriotic spirit of the people.

To me, who visited the United States on a former occasion, but so long ago that Chicago was then but a village, and Philadelphia had not more than one-half its present population, when its railways were only beginning to be made with wooden bridges and almost temporary works, when its vast mineral wealth was nearly untouched, and wood was burned where coal is now consumed, the astonishing changes, and the vast progress since made, appear greater than perhaps they will do to others whose visits have been more frequent. However this may be, what I witnessed at the Exhibition at Philadelphia and in the districts I visited impressed me very strongly with the energy of the people and the vast resources of this great country.

REPORTS ON AWARDS.

GROUP XXVI.

1. Marbeau, Paris, France.

DESIGNS, DOCUMENTS, ETC., OF FOUNDLING HOSPITALS.

Report.—Commended for careful, complete, and satisfactory treatment of the subject.

2. Miguel Garriga & Roca, Barcelona, Spain.

PLANS OF CHURCHES AND MONUMENTS.

Report.—Commended for the plans for churches, and for the artistically conceived monuments. The monument erected to the Spanish army for the glory obtained in the African war is very remarkable.

3. Professor Semper.

PLANS OF TOWN HALL.

Report.—Commended for general excellence of design, monumental and appropriate in style, and thoroughly well studied.

4. State of Massachusetts, Cummings & Seares, Architects.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN.

Report.—Commended for well-studied design, securing economy of service, good distribution of various parts, good ventilation, and cheerful accommodation.

5. State of Ohio, U. S.

OHIO STATE BUILDING.

Report.—Commended for the tasteful and appropriate manner in which the various building materials of the State have been introduced in the construction.

6. State of Massachusetts, U. S.

STATE HOSPITAL FOR INSANE, DANVERS, MASSACHUSETTS.

Report.—Commended for the general excellence of ground plan; securing good distribution of various parts, satisfying very peculiar requirements.

Central administration building (with boiler-house in rear and aloof from other buildings), with wing on either side, *en échelon,* consisting of four pavilions, each of three stories, connected at angles (for the accommodation of the service only), complete isolation of different classes of inmates; rooms cheerful, great thoroughness in essential requisites, securing good ventilation, heating, drainage, water supply, etc.

7. Robert Moser, Baden, Aargau, Switzerland.

HOUSES OF CORRECTION OF CANTONS OF AARGAU AND BASLE AND BASLE CITY.

Report.—Commended for good distribution of ground plans. The cells, workshops, etc., are so located and arranged as to secure the constant supervision of inspector over inmates, whilst the latter are debarred from all communication with each other.

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8. Direction of Public Buildings, P. Müller, Zurich, Switzerland.

PLANS OF THE ZURICH LYING-IN HOSPITAL AND SCHOOLS.

Report.—Commended for general excellency of plan, securing good light, ventilation, and heating; dormitories well classified for the prevention of the spreading of contagious diseases, etc.; nurses' rooms, water-closets, and other accessories, convenient and well located; also for good distribution in ground plan of school-houses.

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9. Otto Hippius, St. Petersburg, Russia.

PROJECT OF A CHURCH.

Report.—Commended for general excellence and artistic merit.

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10. Ramon Tenas, Barcelona, Spain.

PLAN OF THE CHURCH OF THE SACRED HEART.

Report.—Commended for the artistic grandeur of his conception.

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11. Heinrich Ernst, Zurich, Switzerland.

PLAN OF CHILDREN'S HOSPITAL AT ZURICH.

Report.—Remarkably well adapted plan and suitable elevation; central administration building with two wings containing small dormitories (for the prevention of the spreading of contagious diseases); nurses' rooms, water-closets, and accessories well located; veranda for the airing of patients, well introduced; ground floor reserved for surgical cases, in proximity to operating room; every part well lighted, ventilated, and heated.

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12. State of Massachusetts, U. S.

EXHIBIT OF NORMAL SCHOOLS, HOSPITALS, COLLEGES, ETC.

Report.—Commended for the well-devised, thorough, and complete manner in which the various institutions of the State have been exhibited.

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13. J. E. Goss, Geneva, Switzerland.

PLANS OF THE THEATRE IN GENEVA.

Report.—Commended for general excellency of design, good distribution of various parts in plan, entrances, staircases, etc.; well-arranged, truthful, and dignified style of the elevations.

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14. Eduard Guyer, Zurich, Switzerland.

MODERN HOTELS—TREATISE AND PLANS.

Report.—Commended for an able and thorough treatise on hotel industry as regards national economy, influence on domestic habits, construction of hotels, etc.

15. **J. A. A. Waldorp, Chief Engineer of the Hydraulic Department, The Hague, Netherlands.**

DESIGNS FOR WATER SUPPLY AT THE HAGUE.

Report.—Commended as one of the best examples in Europe of a well-conceived and well-executed system of water supply. The water is taken from the downs or sand hills near the coast; it is collected in canals, passed through filters of sand and shells, and then pumped to a wrought-iron reservoir holding one thousand cubic meters and standing about thirty-five meters above the level of the city.

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16. **Joh. Jacob Rieter & Co., Winterthur, Germany.**

TURBINES WITH ACCESSORIES AND WIRE ROPE FOR TRANSMITTING POWER—DESCRIPTION, PLANS, AND PHOTOGRAPHS.

Report.—Commended for its very remarkable illustration of the successful transmission of enormous power from a single water-course to many different factories lying at a distance from it and in different directions. In one instance the power is transmitted through a tunnel.

The most important of those shown is that at Bellegarde, where considerable engineering difficulties had to be overcome before the turbine houses could be even commenced. The power is transmitted to a distance of more than nine hundred and sixty-six meters. Double-grooved rope pulleys are used for carrying power to intermediate stations. Further improvements were made in the wire rope gearing by special apparatus for putting the wire ropes in place; special blocks and machines are used for stretching the same to avoid the drawback of differences in tension of different ropes. There are arrangements to stop the turbines automatically in case of the breaking of a rope. The works are made under the general management of Mr. D. H. Ziegler, engineer.

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17. **J. B. & J. M. Cornell, New York, N. Y., U. S.**

IRON WORK FOR BUILDINGS.

Report.—Commended for general excellence of workmanship, and ability for execution.

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18. **Garry Iron Roofing Co., Cleveland, Ohio, U. S.**

IRON ROOFING.

Report.—Commended for improvement in securing metal roofing by a system of anchors, avoiding all nailing or screwing of joints, and allowing for the contraction and expansion of the metal.

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19. **James L. Jackson, New York, N. Y., U. S.**

IMPROVEMENT IN THE CONSTRUCTION OF STABLES AND FIXTURES.

Report.—Commended for general plan of construction, appropriate proportions, strength, utility, drainage, and superior workmanship.

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20. **Rafael Guastavino, Barcelona, Spain.**

PLAN FOR IMPROVING THE HEALTHFULNESS OF INDUSTRIAL TOWNS.

Report.—Commended for the great number of plans of economical houses for working-men and others.

21. C. E. Löfoenskjold, Bergatorp, Sweden.

DESIGNS FOR PEASANTS' COTTAGES.

Report.—Commended for the successful endeavor to ameliorate the dwellings for working-men, for farm-buildings, etc., in Sweden.

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22. Municipality of Geneva, Switzerland.

SCHOOL-HOUSES AND ACADEMY.

Report.—Commended for excellence of plans, securing good distribution of various parts; thoroughly well lighted and ventilated; also the proper separation of the sexes well secured.

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23. Home Department, The Hague, Netherlands.

DESIGNS OF SCHOOL-HOUSES.

Report.—An interesting exhibit of designs for school-houses; appropriate in plan and elevation.

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24. Municipal Building Office (Niernsee, Director; Berger, Engineer), Vienna, Austria.

PHOTOGRAPHS OF THE MUNICIPAL BATHING ESTABLISHMENTS.

Report.—Commended for practical arrangement and good taste.

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25. The Southern Railway Co., Vienna, Austria.

DESIGNS OF THE SOUTHERN RAILWAY DEPOTS IN VIENNA AND TRIESTE.

Report.—The new station of the Southern Railway Company in Trieste is conspicuous for its large proportions, complete accommodations, and architectural character. The station of the same railway in Vienna is not less remarkable. Its peculiar feature—the elevation of the platform above the level of the streets—has been adapted to very useful accommodations for the traffic, and deserves to be commended.

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26. Department of Public Works of the Canton of Vaud, Switzerland.

DRAWINGS OF PUBLIC WORKS.

Report.—These most important and very interesting works have in view the straightening and regulation of the channels of several rivers and torrents, including, among others, the Rhône and the Grayonne, with a view to increase the uniformity of their flow.

These works were made under the general management of the chief engineer, Louis Gouin.

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27. Home Department, The Hague, Netherlands.

COLLECTION OF PUBLIC WORKS OF THE NETHERLANDS.

Report.—The collection of drawings, models, photographs, etc., of the public works of the Netherlands, gives on a large scale, and in a popular and easily understood way, a most interesting and instructive view of the details of their construction, of their purpose and of their effect.

The whole series, in fact, shows the difference between the conditions existing three hundred years ago and now, together with the means by which the change has been accomplished. This exhibit is not only exhaustively instructive to the engineer interested in the execution of such works, but it is so clear, and covers the details of the work so completely, that it is not less instructive and engaging to the unprofessional visitor.

The execution of the drawings, models, etc., is worthy of all commendation; but they

would lose much of their value without the fine collection of photographs taken at different stages of the execution of important works, showing the actual carrying out of the processes by which they were effected.

We desire to recognize in the most cordial way the marked compliment that is paid to the American people by this very instructive exhibit, which (in the range of works to which it refers) is quite unique in the exhibition, as the works to which it chiefly relates are unique in the world.

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28. Heinrich Schmidt, Chief Engineer, Vienna, Austria.

DRAWINGS AND PAPERS CONCERNING THE CENTRAL ROTUNDA OF THE EXHIBITION BUILDINGS IN VIENNA.

Report.—The central rotunda of the Vienna Exhibition building is a very bold work, the diameter of the circular gallery at the base being one hundred and one meters, and the height of the top lantern being over one hundred meters above the ground level. The description of the iron frame of this rotunda, as presented in the papers exhibited, is a very remarkable record of a work which does great credit to the engineer who planned and executed it.

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29. G. J. Morre, Delft, Netherlands.

STEEPLE AND VENTILATION OF THE LABORATORIUM AT DELFT, NETHERLANDS.

Report.—Commended for the very ingenious system of ventilation and its thorough execution.

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30. Mary Nolan, St. Louis, Mo., U. S.

NOLANUM.

Report.—Nolanum is a novel method of obtaining with great simplicity and economy a very thorough ventilation within the walls of houses from foundation to roof, thus promoting health and comfort, as such walls, being filled with air, would necessarily be better non-conductors of heat. One important novelty claimed for Nolanum is that the blocks constitute the entire thickness of the wall, and form, as soon as laid in position, finished surfaces inside and out, thus needing no plastering, mastic, paper hanging, or other covering. Its fire-proof qualities and the great strength of the material, when burnt, constitute in it an additional recommendation. The application of kaolin clays in the construction of dwellings is novel, and may lead to important results.

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31. The New England Granite Co., Hartford, Conn., U. S.

GRANITE MONUMENTS.

Report.—Commended for the superiority of their exhibit, showing variety of design, excellence of material and workmanship.

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32. Geo. B. Post, New York, N. Y., U. S.

ARCHITECTURAL DESIGNS.

Report.—Commended for beauty and variety of design.

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33. James Barnet, Sydney, New South Wales, Australia.

ARCHITECTURAL DESIGNS.

Report.—Commended for beauty of designs and good treatment of subjects.

34. Leon de Reynaude, Paris, France.

TREATISE ON ARCHITECTURE.

Report.—Commended as being a thorough and concise treatise on architecture, considered esthetically; also as a matter of construction.

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35. Fellner & Helmer, Vienna, Austria.

ARCHITECTURE.

Report.—Commended for excellence of design, plans, and elevations of various theatres, etc.

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36. Champion Fence Co., Kenton, Ohio, U. S.

IRON FENCE.

Report.—Commended for ability and ingenuity shown in the construction of iron fences secured by clasps.

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37. Thomas H. Speakman, Philadelphia, Pa., U. S.

COMBINED WIRE AND WOOD FENCE FOR FARM USE.

Report.—It is simple, cheap, and will apparently do good service.

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38. H. R. Ivis & Co., Montreal, Canada.

MEDIEVAL WROUGHT-IRON GATES.

Report.—Commended for excellence of workmanship and beauty of design.

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39. Drake & Wight, Chicago, Ill., U. S.

FIRE AND WATER RESISTING COLUMNS.

Report.—Commended for the protection of the metal against fire.

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40. L. C. Van Kerkwijk, The Hague, Netherlands.

DESCRIPTION OF THE PUBLIC WORKS OF THE NETHERLANDS.

Report.—It is a very full and detailed account of all of the public works of the Netherlands. While it was prepared expressly for the information of visitors to this Exhibition, it is also interesting and highly instructive for the general reader. It will be a valuable addition to all of our engineering and scientific libraries.

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41. The Military Engineering Department, St. Petersburg, Russia.

ENGINEERING EXHIBITS.

Report.—The Russian Government, in the completeness of its exhibit of maps of all kinds and of other products coming under this group, has, in our opinion, done itself great credit, and is entitled to the gratitude of the Centennial Exposition.

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42. Dr. E. F. van Dissel, Leyden, Netherlands.

DESIGNS AND MODEL OF BRIDGE NEAR BOMMEL.

Report.—Commended for its good conception and for the thorough execution of its work. The three largest spans measure nearly one hundred and twenty meters each. The foundations, abutments, and piers are made on the same principle with those of the Kuilenburg bridge. The wrought iron and steel superstructure is of the same general character, and no less interesting than that of the Kuilenburg bridge. The bridge was built under the general management of Chief-Engineer E. van Diesen.

43. N. H. Nierstrasz, Bosch, Netherlands.

BRIDGE OVER THE RIVER DE YSSEL AT KAMPEN.

Report.—This is a long bridge over one of the arms of the Rhine, and the largest draw-bridge of its kind in the world. The span of the draw is 17 meters, and its width $8\frac{66}{100}$ meters. It is in two sections, each $8\frac{50}{100}$ meters by $8\frac{66}{100}$ meters. The sections are hung at their shore ends, and the bridge is opened by tilting the sections to a perpendicular position. The tilting is effected by the movement of a lever-frame suspended above the bridge.

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44. A. J. van Prehn, Amsterdam, Netherlands.

DESIGNS OF PIVOT OR TURN BRIDGE OVER THE NORTH-SEA CANAL.

Report.—Commended for its well-conceived details and its thorough execution. The piers are of masonry, resting on beton, inclosed in cast-iron cylinders sunk through the mud. The wrought-iron superstructure, carrying double lines of railway, opens two passages for the largest sea-going vessels. This bridge is balanced and carried on a single cast-steel pivot, similarly to that at Dordrecht. Its chief difference from that bridge consists in the mechanism by which the ends are locked or set free by an attendant at the centre of the bridge. This bridge was made under the general management of the above-named chief engineer.

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45. J. G. van den Bergh, Arnhem, Netherlands.

BRIDGE OVER THE HOLLANDSCH DIEP.

Report.—Commended as being grandly conceived, well and very simply planned, and thoroughly executed. This bridge consists of a fixed bridge of fourteen spans of one hundred meters each, and a large revolving draw-bridge with two ship-ways. It crosses a very deep and stormy arm of the sea, and rests partly on very soft mud and partly on more solid ground. Some of the piers are of solid concrete and masonry, inclosed in iron tubes to above high-water mark, and supported upon filled caissons sunk with the aid of compressed air to the solid bottom. Where the mud is less deep, the beton, which supports the masonry below low-water mark, rests directly upon piles. The superstructure of the fixed bridges, although somewhat different in principle from that of the Kuilenburg bridge, is not less worthy of attention. The pivot bridge for one line of railway turns on a simple forged pivot, and is especially remarkable for the manner of its support upon the abutment piers. This interesting bridge was made under the general management of Chief-Engineer J. G. van den Bergh.

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46. N. F. Michaëlis, The Hague, Netherlands.

BRIDGE OVER THE RIVER DE MAAS, NEAR DORDRECHT.

Report.—Commended for the ingenious conception of its interesting details, and for its thorough execution. The design shows only the larger of the two draw-bridges,—that for sea-going vessels. The whole length of this bridge is $53\frac{56}{100}$ meters. It carries a double track. The draw-bridges are of cast steel. The steel superstructure is exactly balanced, its two halves, lateral and longitudinal, being identical in all their parts. It moves on a single forged pivot, the bearing being above the centre of gravity. Any tendency to lateral swinging (in high winds) while the bridge is being turned is checked by a single stop-wheel at each side. When open or shut, the bridge is securely supported at its ends. In moving, the whole burden is carried from its pivot-point by three bolts, each seventeen centimeters in diameter. This system, which is peculiar to Holland, has been found by experience to stand remarkably well. The works are made under the general management of the above-named director, N. F. Michaëlis.

47. G. van Diesen, Middelburg, Netherlands.

BRIDGE OVER THE RIVER DE LEK, NEAR KUILENBURG.

Report.—Commended for its grand conception, being well planned, and most interesting from its simplicity and good construction, and for its thorough execution. The Kuilenburg bridge, whose largest span is one hundred and fifty meters, is the largest girder bridge in Europe made for a double line of railway. The foundations of beton are inclosed in sheet piling. The abutments and piers are of stone and brick masonry. The superstructure is of wrought iron and steel. The bridge was built under the general management of Chief Engineer G. van Diesen.

48. Caminada Brothers, Rotterdam, Netherlands.

MODEL OF BRIDGE OVER THE RIVER DE LEK, NEAR KUILENBURG.

Report.—Commended as a carefully-made model, illustrating the construction of this bridge.

49. A. W. Stortenbeker, Rotterdam, Netherlands.

PLANS AND DESIGNS OF BRIDGES.

Report.—Commended as being excellent specimens of technical drawing, having the additional merit of good artistic accessories.

50. Kannemans, Breda, Netherlands.

PLANS AND DESIGNS OF BRIDGES, ETC.

Report.—Commended as being excellent specimens of technical drawing, having the additional merit of having good, artistic accessories.

51. P. J. H. Hayward, Leeuwarden, Netherlands.

HARBOR WORKS AT HARLINGEN.

Report.—This harbor consists of two breakwaters, built out into the Zuyder Zee, consisting partly of sunken cribs of osier wicker work and partly of earthwork covered with regularly-laid stones. In addition to these, there are two wooden piers. The harbor is supplemented by a guide dam one thousand meters long, far out in the Zuyder Zee, which directs the ebb tide into the channel with the intention of keeping it scoured. It is an instructive example of Dutch harbor work, and, although not so grand as those on the North Sea, and less exposed to storms, it has stood uncommonly well.

52. L. J. Kesper, Amsterdam, Netherlands.

HARBOR WORKS AND DOCKS AT FLUSHING.

Report.—The great and important harbor works and interior docks at Flushing make this place one of the best ports on the continent of Europe. A perfectly-finished copper model of one of the wrought-iron valve gates shows the manner of construction. These very important works were made under the general management of Chief-Engineer M. Simon, Gz.

53. M. Simon, Gz., Flushing, Netherlands.

DAMS AT EASTERN SCHELDE AND SLOE.

Report.—These important dams constitute a part of the embankment of the railway from Roosendaal to Flushing. They are made with osier wicker work cribs, loaded with stones and earth and sunk at the sides of the embankment to above high-water mark. The space

between these is filled, and the upper part of the embankment is made with earth and sand. The slopes are first covered to a thickness of about one meter with clay, and then sheathed with stone work to about the highest reach of the waves. The higher parts are covered with sods; the work stands uncommonly well, without being affected by the waves of the heaviest storms. The longer of these dikes measures about five thousand meters, three thousand six hundred and thirty-seven meters of it in tide water, with an extreme variation of tide of six and nine-tenths meters. The whole dike was necessarily completed in one summer season.

54. J. F. W. Conrad, Haarlem, Netherlands.

LOCK WILLIAM III.

Report.—This is an admirable example of the method of hydraulic construction peculiar to Holland. It is economically planned and thoroughly built. Though of great size, adequate to the entire traffic of the North Holland Canal, it is built on a wooden floor supported by a forest of piles of Norway pine driven through the mud to the hard ground.

55. H. S. J. Rose, The Hague, Netherlands.

RIVER IMPROVEMENTS OF THE NEW MEREWEDE.

Report.—It is an example of the methods by which Dutch engineers overcome the constantly-recurring difficulties arising from the deposit of silt and the formation of ice dams in their rivers. These difficulties increased until the necessity for relief became of national importance. The map shows the principle adopted, consisting in giving a regular width to the river proportionate to the quantity of its flow. As a consequence, the action of the current secures in most cases a regular depth of channel for navigation. The width of the stream is regulated by the use of jetties (of sunken cribs of osier wicker work) thrown out from the banks. A special drawing gives all the details of these constructions.

56. A. K. P. F. R. van Hasselt, Hilversum, Netherlands.

DESIGNS FOR FOUNDATIONS FOR THE PIERS IN THE RAILWAY BRIDGE AT ROTTERDAM.

Report.—Commended for the good conception of its most interesting details and for its thorough execution. The piers of the railway bridge over the Maas at Rotterdam stand upon filled caissons, which were sunk by the aid of compressed air to the hard bottom through from nine to ten meters of soft mud. The works were made under the general management of N. F. Michaëlis, of 's Gravenhage (The Hague), Director of the Netherlands Railways, with the assistance of—1st, the above-named Engineer van Hasselt; 2d. M. Simons, of Rotterdam, State Railway Engineer; and 3d, Thr. L. A. Sandberg, of Rotterdam, State Railway Engineer.

57. J. Strootman, Assen, Netherlands.

DRY DOCKS AT THE HELDER.

Report.—These works are extensive and complete. Great engineering difficulties had to be overcome. They are very well worthy of attention.

58. The Amsterdam Canal Co., Amsterdam, Netherlands.

DESIGNS AND MODEL OF CANAL FROM AMSTERDAM TO THE NORTH SEA.

Report.—Commended for its grand conception and thorough execution. The Amsterdam North Sea Canal is the largest work of its kind after the Suez Canal. It has been ten years in progress, and will be completed in about two years more. A large harbor of refuge of sufficient capacity for the largest vessels is being constructed at its outlet into the North Sea.

59. P. Caland, The Hague, Netherlands.

DESIGNS AND RELIEF MODEL OF THE NEW WATERWAY FROM ROTTERDAM TO THE NORTH SEA.

Report.—Commended for its grand conception and thorough execution. This work comprised: 1. The regulation of the Maas for a certain distance. 2. The cutting of a more direct course for its outlet, partly through the high sand dunes. 3. The protection of the outlet and the creation of a harbor. The two large breakwater jetties in the North Sea are the largest works of this kind that ever were made on the continent of Europe. They are made by sinking, one over another, cribs of osier wicker work, loading these with large blocks of granite. These successive cribs serve the purpose of bonding the structure. They are most interesting from the simplicity and cheapness of their construction. They are faced from base to base with large stones very carefully laid without mortar. The jetties so made stand the heaviest storms of the North Sea remarkably well. Along the top runs a wooden pathway, for convenience in handling ropes and to give access to the light-house on one of the piers.

60. C. A. Eckstien, The Hague, Netherlands.

TOPOGRAPHICAL MAPS.

Report.—These topographical maps of the Dutch colonies show great beauty of execution, and are in colors. They show more care in surveying than is usually exercised by a mother country towards its colonies, and are printed by a special ingenious process, using only three stones, by which all colors are produced. Mr. Eckstien executed this work.

61. H. F. Fijnje van Salverda, Tiel, Netherlands.

SYSTEM OF ENGINE DRAINING.

Report.—This is an extremely simple double-acting force-pump, immersed in the water which it is charged with lifting. It is especially applicable to the conditions of the "polder" draining of Holland and of all similar works. Ample experiments attest the efficiency of this pump, and prove it to be most economical for the lifting of large volumes of water, consuming about one and eight-tenths kilogrammes of coal per horse-power, per hour.

62. Navy Department, The Hague, Netherlands.

HYDROGRAPHIC CHARTS AND MAPS OF HOLLAND.

Report.—Commended for the accuracy and beauty of the execution.

63. Commission for the Improvement of the Danube, Vienna, Austria.

THE REGULATION AND THE RECTIFICATION OF THE DANUBE.

Report.—This work, which has for its chief purpose the prevention of severe periodical inundations in the lower parts of the city, is especially worthy of remark as being the first example in Europe where, in straightening the course of a large river, the new cutting was made immediately to the full size of the river bed, no material being left to be removed by the scouring action of the current and to be deposited below. The works are made under the general direction of Mr. Gustave Wex, K. K. Ministerialrath.

64. Andre Reboucas, Rio de Janeiro, Brazil.

WOODEN DOCKS AT RIO DE JANEIRO.

Report.—This exhibit is well entitled to recognition as affording a good example of wooden docks or landing stages with warehouses, introduced only by the great energy of their engineer, and now demonstrated to be very practical and of substantial utility.

65. Friedrich Bömches, Vienna, Austria.

DESIGNS AND REPORTS CONCERNING TRIESTE HARBOR.

Report.—A very important improvement of Trieste harbor has been effected since the year 1870 by the Austrian Government. The new harbor consists of three basins five hundred meters wide and eight and a half meters deep, protected by a breakwater twelve hundred meters long. The construction of the quays and breakwater with the combined systems of "pierres perdues" and artificial stones on a very unsound bottom has encountered serious difficulties, and has given an opportunity to improve these systems of foundations, while the necessity for rapidly completing an immense amount of work has led to the increasing of the efficiency of means for excavating and transportation to the greatest extent possible. The designs and reports presented on this subject are of a very instructive character, and must conduce in an important degree to the advancement of civil engineering.

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66. A. V. de Borja Castro, Rio de Janeiro, Brazil.

CUSTOM-HOUSE BASIN AT RIO DE JANEIRO.

Report.—Commended for its successful solution of the problem of reconstructing an important pier (exposed to strong waves) after it had, from its inadequate foundations, become seriously displaced.

The reconstruction has been very well conducted, and the engineering difficulties have been skillfully overcome.

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67. Dinaburg Arsenal, Dinaburg, Russia.

PONTOON BRIDGE AND MAPS.

Report.—The pontoons are made of boiler iron, giving great strength with lightness. The balks and chess are as usual.

Maps of defense of Sebastopol; well executed.

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68. Dr. Emil Winkler, Vienna, Austria.

STUDIES CONCERNING BRIDGES AND THE THEORY OF THEIR CONSTRUCTION, AND CONCERNING THE ELASTICITY OF DIFFERENT MATERIALS.

Report.—Commended for their evidence of profound and careful study in an important field.

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69. Government of the Canton St. Gallen, Switzerland.

SYSTEM OF ROADS AND HIGHWAY BRIDGES; CORRECTION OF THE RHINE.

Report.—The most interesting feature of this exhibit is that which describes the regulation of the channel of the Rhine. The upper portion is guarded by parallel dams, above ordinary high water. The lower portion is guarded by two sets of dams, one set placed at ordinary low water and the other at ordinary high water. The stream is straightened by a large cutting near Diepoldsau. These works are made under the general management of Mr. A. Wey, engineer at St. Gallen.

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70. Silverio Augusto Pereira da Silva, Aveiro, Portugal.

MODEL OF BRIDGE IN WOOD AND IRON.

Report.—Commended for the great simplicity of its construction. In view of the particular condition of the country, the bridge which this model represents solves a very important economical problem.

71. Detroit Bridge and Iron Works, Detroit, Michigan, U. S.

BRIDGE OVER THE MISSOURI RIVER AT ST. JOSEPH, MISSOURI.

Report.—This bridge is remarkable for the difficulties attending the construction of its foundations in the Missouri River, having been sunk to the bed-rock in that stream. Commended for the substantial character of the masonry of its piers, the economy of design in the superstructure, and the general excellency of workmanship.

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72. Clarke, Reeves, & Co., Philadelphia, Pa., U. S.

THE GIRARD AVENUE BRIDGE ACROSS THE SCHUYLKILL.

Report.—Messrs. Clark, Reeves, & Co. give a useful engineering exhibit. The Girard Avenue bridge, to which they especially call attention, is about equal in size to the bridges across the Thames in London. It is a good and well-designed engineering work, and is an excellent specimen of the method of bridge building advocated by this firm. They give many other samples of structures erected by them, some of very large size, that designed for Lewiston, Niagara, having a span of six hundred feet.

In addition to this report, the Judges desire to commend the Girard Avenue bridge at Philadelphia for the beauty of its design.

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73. Charles Macdonald, New York, N. Y., U. S.

DRAWINGS OF BRIDGES EXECUTED.

Report.—The drawings are explanatory of bridges that have been executed, of considerable size, and which appear to be well designed; for instance, the Charlotte drawbridge, and the Oswego bridge, on the Watertown and Ogdensburg Railway.

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74. J. Dutton Steele, Pottstown, Pa., U. S.

MODEL, DRAWING, AND DESCRIPTION OF THE FALLS STONE BRIDGE.

Report.—This bridge has six oblique stone arches, each of eighty-three feet span, and is a good specimen of the ribbed stone system of masonry in arches in lieu of building them in spiral courses, which is more commonly the method adopted in building oblique or skew bridges.

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75. The Keystone Bridge Co., Philadelphia, Pa., U. S.

IMPROVEMENT IN PIVOT OR SWING BRIDGES, AND RIVETLESS COLUMNS.

Report.—This company exhibited a useful and instructive selection of engineering structures.

The Raritan Bay pivot or swing bridge, of which a carefully constructed model is exhibited, is of itself a work worthy of notice.

It is the largest pivot or swing bridge yet constructed, the movable portion being four hundred and seventy-two feet in length, and it presents some important details in design and execution.

The rivetless tubular columns, while giving the requisite strength, admit of forms and proportions suitable for architectural purposes as well as for engineering works.

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76. Frederick E. Sickels, Providence, R. I., U. S.

PLANS FOR SINKING AND HOLDING PNEUMATIC PILES.

Report.—This method is a valuable improvement upon the ordinary method of sinking pneumatic piles, the air lock having hitherto been always used above the water, thus necessitating its removal as each section of pile had to be added, and the replacement of the

air lock afterwards. The air lock, by this improvement, is substantially constituted of two diaphragms placed in the lower part of the pile, and of the walls of the pile; and thus the necessity of its removal is avoided, by which great inconvenience and delay in the work are prevented. It was successfully used in sinking some of the piers of the Omaha bridge.

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77. J. Herbert Shedd, Providence, R. I., U. S.

HYDRANT.

Report.—Commended as a hydrant with all necessary appurtenances and appliances; a service pipe and its appliances; and a cast-iron catch basin trap. These appliances are the results of a careful study of the conditions existing in Providence, and are admirably adapted thereto. They include improvements and modifications which are of quite general availability.

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78. Wm. Smith & Sons, Barnard Castle, Durham, England.

ONE-HORSE MACHINE FOR CLEANING STREETS AND ROADS OF DUST AND MUD.

Report.—They are simple, strong, and well constructed, and seem well adapted for their purpose.

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79. W. C. Allison & Co., Philadelphia, Pa., U. S.

REVOLVING SCRAPER FOR REMOVING EARTH.

Report.—This seems to be a meritorious and useful invention, and an economic method of forming embankments.

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80. Major E. F. Von Hoffman, U. S. Army.

SOUNDING MACHINE.

Report.—Commended in that it displays great ingenuity in facilitating sounding in shallow streams, multiplying the number taken many times, and insuring accuracy.

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81. The Gunpowder Pile-Driver Co., Philadelphia, Pa., U. S.

THE GUNPOWDER PILE-DRIVING MACHINE.

Report.—This machine is ingenious in its construction. It drives piles very well when in order, and saves the heads of the piles.

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82. Joseph M. Wilson, Philadelphia, Pa., U. S.

AN EXHIBIT OF WORKING DRAWINGS OF BRIDGES AND WORK ON THE PENNSYLVANIA RAILWAY.

Report.—The drawings are explanatory of important and well-designed bridges and works executed on the Pennsylvania Railway under Mr. Wilson's direction, such as the Trenton bridge over the river Delaware, the suspension bridge, and others.

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83. Government of Chili, Poisson, Verano, and Romero.

PLAN OF SANTIAGO AND ANGELAS RAILWAYS.

Report.—Of the two railroads whose plans have been exhibited, one is finished, and the other will be in August. The technical provisions of both are the most favorable, and prove the great skill of the engineers.

84. Richard Price Morgan, Jr., Bloomington, Ill., U. S.

ELEVATED STEAM RAILWAY.

Report.—This design seems well calculated to meet the increasing demand for rapid transit in crowded cities, without incurring the enormous expense involved in the condemnation of valuable property to secure the right of way and without obstructing the roadway.

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85. The Swiss Northeast Railway Co., Zurich, Switzerland.

DESIGNS AND PAPERS RELATING TO THE CONSTRUCTION OF RAILWAYS.

Report.—The Swiss Northeast Railway Co. submits papers and drawings concerning its method of construction. Among these are the designs of an iron bridge at Brugg, fifty-seven meters span, built on a curve, on the Pauli principle, which are worthy of commendation. These exhibits merit the careful attention of railway engineers, as they give evidence of thorough study and of sound understanding of the principles of railway construction.

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86. Franz Rziha, Vienna, Austria.

THE TUNNEL-CONSTRUCTION GUIDE.

Report.—This treatise on tunnel construction, presented by Mr. Rziha, is very complete. It gives new and valuable instructions in this branch of civil engineering, to which it is a very important contribution, well worthy of the study of all practical men engaged in tunnel construction.

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87. St. Gothard Railway Co., Zurich, Switzerland.

DRAWINGS AND REPORTS ON THE ST. GOTHARD RAILWAY.

Report.—The St. Gothard Railway, which is the fourth railway across the Alps, may be considered the most prominent, as the length of the tunnel at the summit is greater than in either of the others, as appears from the following figures:

	Length of the Tunnel.
St. Gothard	14,900 Meters.
Mont Cenis	12,200 "
Semmering	1430 "
Brunnen	600 "

The planning of this railway, whose general direction follows the upper parts of the valleys of Reno and Tessin rivers, has had to consider the greatest difficulties, which have given occasion for a thorough study on the part of the engineers, and for displaying remarkable skill in devising economical methods of construction, and in providing for the safe working of the road, in spite of most unfavorable conditions. The concentration of the steepest gradients, and a careful consideration of the geological and meteorological conditions, are the most interesting features of the scheme.

No less attention has been paid to the mechanical means employed for boring the long tunnel between Gothenen and Aivolo across granitic gneiss and quartziferous slates.

The drilling machines used at the Mont Cenis tunnel have been improved in the most efficient manner, as also air compressors; several new sorts of apparatus have been employed for the ventilation of the tunnel, and for the working of locomotives and lifting-engines by compressed air; and it is computed that the time occupied in the work will be shortened by reason of the increasing perfection of means adopted by the company.

All these exhibits are of the greatest interest as giving very complete information upon this most important work, and as making a new progress in the art of engineering.

88. St. Gothard Railway Co., Zurich, Switzerland.

GEOLOGICAL PROFILE OF ST. GOTHARD.

Report.—It is very remarkably done. It indicates the mineral character of the rocks cut through by the works of the tunnel, their direction and inclination, the quantity of water, and the temperature at the different points of the tunnel. Its profiles represent a length of two thousand seven hundred and sixty kilometers at the south entrance, "Aivolo," and two kilometers at the north entrance, "Gothenen." Scale, 1 : 200.

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89. Tobler, Chief Engineer Uetliberg Railway, Zurich, Switzerland.

DESCRIPTION AND DRAWINGS OF THE UETLIBERG RAILROAD.

Report.—This railway, running from Zurich to the Uetliberg, has been constructed over a total length of nine kilometers, with a gradient of seventy to one thousand, and is worked with the greatest success and economy. It is of great interest as an illustration of a mountain railway system where the use of ordinary locomotives on very steep gradients has proved practical because of well-considered arrangements adapted to the special situation of the railway, and of the efficiency of a novel compressed air brake.

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90. Director-General of the Ordnance Survey, Southampton, Great Britain.

MAPS OF ORDNANCE SURVEY.

Report.—Commended for extreme accuracy of work and beauty of execution, and excellent manner in which the large maps are reduced by photography.

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91. Depot of War, Madrid, Spain.

SOLDIERS' TRAVELING CARDS.

Report.—Commended for correctness of execution and very good workmanship.

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92. Topographical Corps of Military Engineers, Madrid, Spain.

PLAN OF BARCELONA.

Report.—It is perfectly executed, comprising the survey of the neighboring grounds.

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93. The Directors of the Ecole Nationale des Ponts et Chaussées, Paris, France.

COLLECTION OF PAPERS, DRAWINGS, AND REPORTS.

Report.—The French Ecole Nationale des Ponts et Chaussées, the prominent school of civil engineering, submits a very complete collection of papers and drawings relating to professional instruction, and of reports on the public works of several countries made by French engineers. This collection is very interesting, and gives a high idea of the ability and attainments of the directors and professors of this celebrated school. It affords also an opportunity to acknowledge the distinguished contributions which this institution has rendered to the engineering of the world.

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94. H. F. Krause, New York, N. Y., U. S.

MAPS.

Report.—Commended as a quick and easy means of delineating the topography of a country by shades, and then reproducing on a reduced scale by photography.

95. Otto Sibeth, New York, N. Y., U. S.

TOPOGRAPHICAL MAP.

Report.—Commended for the extreme beauty of the drawing, and apparent accuracy of the details.

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96. E. B. Van Winkle, New York, N. Y., U. S.

ATLAS.

Report.—Each lot is accurately laid down and its dimensions plainly given. The sewers, street-paving, and other information concerning it are accurately given at a glance.

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97. J. Bien, New York, N. Y., U. S.

MAPS.

Report.—The maps are printed in colors from stones special for each color. The registering is excellent, and the maps are exceedingly creditable specimens of map printing and engraving. The printing of statistical maps in colors has also been successfully done by Mr. Bien.

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98. R. P. Rothwell, New York, N. Y., U. S.

MAPS OF SURVEYS.

Report.—The surveys, so far as is indicated by the maps, show great pains. The maps are well drawn, and the object of the survey is evidently well attained.

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99. Justus Perthes, Gotha, Germany.

MAPS.

Report.—Commended for the beautiful execution of a map of the world—Mercator's projection.

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100. Royal Swedish General Staff, Stockholm, Sweden.

MAPS.

Report.—Commended for the scientific manner in which the triangulation is laid out, and the beauty of execution.

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101. Ernst Schotte & Co., Berlin, Germany.

RELIEF MAPS AND GLOBES.

Report.—The maps and globes are well executed and useful as assistants in education.

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102. Topographical Section of the General Staff, St. Petersburg, Russia.

MAPS, CHARTS, ETC.

Report.—The processes employed have received extraordinary developments, photographic, heliographic, and lithographic, not exceeded in any exhibit, in my opinion.

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103. Wurster, Randegger, & Co., Winterthur, Zurich, Switzerland.

MAPS.

Report.—Commended for extreme beauty of painting and engraving.

104. Demetrius Timiriasef, St. Petersburg, Russia.

STATISTICAL ATLAS.

Report.—Commended in that it shows at a glance the statistical information as to the development of manufactures, amount of raw material, and number of men employed.

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105. Dr. H. Kiepert, Berlin, Germany.

MAPS AND GLOBES.

Report.—Commended for the neatness and plainness of execution and high style of finish.

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106. John Bartholomew, Edinburgh, Scotland.

MAPS AND PLANS OF TOWNS.

Report.—Commended for the apparent accuracy and the neatness of execution.

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107. John Bloch, Warsaw, Russia.

STATISTICAL MAPS OF RUSSIAN RAILROAD SOCIETIES.

Report.—They show at a glance the products carried over the roads, the number of passengers, etc., in an ingenious and, I believe, original manner.

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108. Hachette & Co., Paris, France.

MAPS.

Report.—Commended for beauty of execution.

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109. Eduard Beck, Bern, Switzerland.

MAPS (RAISED).

Report.—They are good for educational purposes.

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110. Kingdom of Prussia.

MAPS.

Report.—They are particularly good, showing the geological formations, horizontal curves, absolute heights, location of ores, etc.

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111. Government of Victoria, Australia.

MAPS.

Report.—Commended for the plain manner in which the occupation of the land is shown.

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112. Royal Staff of the Government of Denmark, Copenhagen.

MAPS.

Report.—Commended for the beautiful execution of the maps and their exceeding plainness, by which cultivated and uncultivated ground are readily determined.

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113. Cubas Antonio Garcia, City of Mexico, Mexico.

MAPS AND ATLAS.

Report.—Commended for a geographical administrative wall chart of the Republic of Mexico, intended for schools; also for an atlas, very minute in its details, with a map of each state, with explanations of the physical, industrial, and agricultural resources, together with statistics of the population and commerce of each state.

114. Government of Chili.

GEOLOGICAL CHART OF CHILI.

Report.—This chart has the double interest of topography and geology. Its worth has been acknowledged by the Geographical Society of Paris, which granted to its author the great Livingstone medal. It is the most important work of its kind in South America.

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115. The Economical Survey of Sweden, Stockholm, Sweden.

AGRICULTURAL MAP.

Report.—It is well and accurately made, showing distinctly the parts of the country cultivated, that can be cultivated, etc.

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116. Direction of Mondego and Figueira Bar Works, Figueira, Portugal.

MAPS AND TREATISE.

Report.—Commended for the very interesting and complete treatise and maps relative to the regulation of the river Mondego, and jetty works near Figueira for the improvement of the port and fluvial navigation.

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117. Direction of Public Works of the Canton of Bern, Switzerland.

PLANS, MAPS, ATLASES, LITERARY WORKS, BRIDGES FOR PUBLIC ROADS, CORRECTION OF RIVERS OF THE JURA MOUNTAINS.

Report.—The important problems considered relate to the regulation and rectification of the river Aar between Thun and Uettingem. The results obtained owe their accuracy to the most valuable investigations of the American engineers Humphreys and Abbott, made in connection with their examination of the Mississippi River. Up to the time of these investigations, accurate estimates of the mean velocity of rivers was impossible. These investigations related to large rivers. Later, MM. Darcy and Bazin applied the principles thus developed to smaller streams, and showed that the velocity of the whole body of water cannot be accurately measured by the old formula $V = C\ V\ R\ T$, as it depends always on the roughness of the wetted periphery and the rate of inclination. These new developments are in this exhibit applied to the special conditions of the river Aar, the accuracy of the result obtained being demonstrated in a conclusive and interesting way.

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118. Daniel de Cortazar, Madrid, Spain.

GEOLOGICAL MAP OF THE PROVINCE OF CUENCA.

Report.—Commended for the excellent geological map, with a complete description, of the province of Cuenca.

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119. Valerien de Möller, St. Petersburg, Russia.

GEOLOGICAL CHART OF THE URAL.

Report.—Commended for the remarkable information which it furnishes on the geology of the region. Executed on a scale of $\frac{1}{840000}$.

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120. Professor Barbot-de-Marny, St. Petersburg, Russia.

GEOLOGICAL MAP OF THE GOVERNMENT OF KHERSON.

Report.—Commended for its remarkable execution.

121. Helmerson, St. Petersburg, Russia.

GENERAL GEOLOGICAL MAP OF RUSSIA, AND STRATUM MAP OF THE COAL DISTRICT OF THE DON.

Report.—This chart, which has been executed under the direction of Helmerson, is very remarkable for its careful determination of the direction and inclination of the strata of the ground, and of the layers of coal, scale of one and a half miles to the inch.

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122. Michigan Survey Commission, T. B. Brooks.

MICHIGAN GEOLOGICAL CHARTS.

Report.—These works, executed with the greatest perfection, have contributed very much to the development of geological knowledge and of the State industry.

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123. Government of New Zealand.

GEOLOGICAL MAPS AND CHARTS OF THE IRON STUDIES.

Report.—From their completeness, these works are worthy of consideration.

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124. General Direction of the Geodetical, Topographical, Hydrographical, and Geological Labors, Lisbon, Portugal.

MAPS, TOPOGRAPHICAL AND GEOLOGICAL.

Report.—They are accurately and neatly done, and deserve commendation for the manner of determining cultivated and uncultivated ground, differences of level, topographical features, etc. Executed by "The Direction of Geodetic Surveys."

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125. Carlo Maineri, Milan, Italy.

CHART IN RELIEF.

Report.—This chart is perfectly executed. It shows the administrative limits, the railroad lines, the glaciers of the mountains, etc.

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126. Swiss Geological Commission, Bern, Switzerland.

GEOLOGICAL CHART OF SWITZERLAND.

Report.—It is executed on a scale of $\frac{1}{100000}$. It has nineteen complete plates. The geological determination of the ground is remarkably done.

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127. Col. C. Rittich, General Staff, St. Petersburg, Russia.

ETHNOGRAPHICAL MAP OF RUSSIA.

Report.—It shows at a glance the areas of races inhabiting Russia, carefully and accurately done; figures representing the races accompany the map.

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128. Hydrographical Direction, Madrid, Spain.

HYDROGRAPHICAL CHARTS.

Report.—Commended for the excellent execution of the hydrographical maps of Spain.

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129. Observatory of Infante D. Luiz, Lisbon, Portugal.

METEOROLOGICAL AND MAGNETIC CHARTS.

Report.—These charts contain the meteorological and magnetic observations made from 1856 to 1871. They are commendable on account of their details. They also comprise the charts of the winds of the Gulf of Guinea, and other very interesting and very useful charts.

130. Officers of the Austrian Board of Trade (Post Coires Bureau), Vienna, Austria.

POSTAL AND RAILWAY MAP OF AUSTRIA.

Report.—Commended for extreme neatness of execution, the ease with which the large amount of information contained on them can be seen and used, and for ingenious arrangement. The success of the attempt to print them on linen assures their durability, and is, with the neatness of mounting, etc., deserving of mention to the credit of R. V. Waldheim, of Vienna.

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131. General de Beaurepaire Rohan, Rio de Janeiro, Brazil.

GEOGRAPHICAL CHARTS.

Report.—The charts are well executed. They comprise all the provinces of Brazil.

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132. Administrative Board of Ponta Delgada Artificial Harbor Works, Ponta Delgada, Portugal.

PLAN OF ARTIFICIAL PORT OF PONTA DELGADA.

Report.—This plan shows the project of the works of the artificial port of Ponta Delgada, which are now being executed. It is accompanied by a very important collection of the building materials which are employed in that construction. This project is well made.

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133. Suez Canal Co., Paris, France.

MAPS AND DRAWINGS RELATING TO SUEZ CANAL.

Report.—The maps and drawings exhibited necessarily give but a slight idea of the magnitude of the enterprise and of the difficulties overcome in carrying it out. The grandeur of the scheme, the ability displayed in the execution, and the importance of the results have been appreciated already by the most competent judges, and the increase of the traffic since the completion of the canal has exceeded the expectations of the promoters. We desire to express our admiration for Mr. De Lesseps and his prominent assistants, whose work we proclaim the grandest of modern times.

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134. Manuel de la Paz Mosquera, Jaen, Spain.

CHART OF THE PROVINCE OF JAEN.

Report.—This chart is a manuscript, and its execution very remarkable.

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135. Duhamel, Paris, France.

MAP OF DEPARTMENT OF THE HAUTE-MARNE.

Report.—Commended for excellent execution, much above ordinary map work.

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136. Ch. Delagrave, Paris, France.

GLOBES AND PLASTER CASTS SHOWING CONTOURS OF GROUND.

Report.—Commended for excellence of construction.

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137. Norwegian Tourist Club, Christiania, Norway.

MAPS OF NORWAY.

Report.—They show elevations in colors, which are easily designated from a scale shown.

138. Francisco Coello & Quesada, Madrid, Spain.

GEOGRAPHICAL CHARTS.

Report.—Commended for the superior execution of the geographical charts of the provinces of Spain.

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139. Museum of Military Engineers, Madrid, Spain.

VARIOUS MODELS OF MOUNTAINS, PLACES, AND PORTS.

Report.—These models are very well done. The model of the ground occupied by the Spanish army during the African war is magnificent. There are twenty-one different models constructed by the military employees of the museum.

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140. Philip Antonof, St. Petersburg, Russia.

PLAN AND RAISED PLAN OF SEBASTOPOL, AND STATISTICAL CHARTS.

Report.—Commended as an excellent representation of that style of exhibition.

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141. Federal Topographical Bureau, Bern, Switzerland.

MAPS AND ATLASES OF SWITZERLAND.

Report.—Commended as an exceedingly complete and detailed collection of maps of the country.

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142. A. de Dartien, Paris, France.

MAP OF FRANCE, SHOWING LIGHT-HOUSES, RIVERS, ETC.

Report.—It is exceedingly well executed, showing the objects it intends to represent with great clearness.

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143. Hydrographic Department, Rio de Janeiro, Brazil.

CHARTS OF THE COAST OF BRAZIL.

Report.—The charts are well executed, and are easily understood by navigators, showing a state of the art fully up to that of other nations. They are executed by officers of army engineers and officers of the navy.

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144. Geographical Survey of Norway (Lieutenant-Colonel Broch), Christiania, Norway.

MAPS OF NORWAY.

Report.—Commended for the beautiful execution of the maps, and the readiness with which information can be obtained from them.

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145. French Government.

MAP OF FRANCE SHOWING DEPOSITS OF PHOSPHATE OF LIME.

Report.—It gives an excellent example of this kind of map.

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146. Government of Japan.

MAPS OF THE COAST OF JAPAN.

Report.—They show a wonderful advance in civilization by their accuracy, and the fact that they have been made at all.

147. Government of Queensland, Australia.

MAPS OF QUEENSLAND.

Report.—Commended for the admirable manner in which the mineral lands are shown at a glance.

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148. Empire of Brazil, Com. Costa Asevedo, of Rio de Janeiro, E. Siais, of Rio de Janeiro, Halfield, of Minas.

MAPS.

Report.—They are maps of the interior of Brazil, including the views. They show more accuracy (apparently) than is usual in surveys of so extensive a country as Brazil.

The plans are made for the Amazon by Com. Costa Asevedo; for the San Francisco Superior, by E. Siais; for the San Francisco Inferior, by Halfield.

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149. Dr. F. C. Schübeler, Christiania, Norway.

BOTANICAL AND GEOGRAPHICAL MAPS OF NORWAY.

Report.—Commended for the ingenious arrangement by which the areas of habitations of animals, and growth of various plants, are given, and for good execution of the work.

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150. Government of the Argentine Republic, Buenos Ayres.

MAPS OF THE IRON MINES OF THE REPUBLIC, AND CHARTS OF THE PROVINCES AND LA PLATA RIVER.

Report.—These works, although not so perfect as could be desired, show the good wishes of the administration in creating a topographic department and supplying charts of its provinces, of the coast, and of all its railroads.

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151. Admiralty Hydrographic Department, St. Petersburg, Russia.

MARINE CHARTS.

Report.—Well executed; depths given by colors; also charts showing light-houses, aids to navigation, etc.; all good.

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152. Henry Pettit & Joseph M. Wilson, Philadelphia, Pa., U. S.

MAIN EXHIBITION BUILDING, MACHINERY HALL, AND ADJACENT BOILER-HOUSES, FOR THE INTERNATIONAL EXHIBITION OF 1876.

Report.—Commended for the satisfactory and appropriate solution of the problems, both in plan and elevation, light and appropriate construction, combining cheapness and elegance.

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153. George Hayes, New York, N. Y., U. S.

SKYLIGHTS, VENTILATORS, LEADERS, ETC.

Report.—Commended for the ingenuity displayed in the construction of the various articles, based on sound principles, and especially for the perfection arrived at in the construction of skylights.

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154. Hinsdale Doyle Granite Co., New York, N. Y., U. S.

MONUMENTS.

Report.—Commended for the excellence of workmanship. Monuments in Hallowell and Fox Island granites fine in texture and even in color.

155. **Joseph M. Wilson, Philadelphia, Pa., U. S.**

DESIGN OF PASSENGER RAILWAY STATION, WASHINGTON, D.C., AND PLANS OF SUNDRY RAILWAY STATIONS, PENNSYLVANIA RAILROAD, ABATTOIR, WEST PHILADELPHIA, ETC.

Report.—Well designed, simple, and appropriate in style.

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156. **Geographical and Statistical Institute of Madrid, Spain.**

GEOGRAPHICAL MAPS.

Report.—They are executed remarkably well; the precision levelings deserve special mention. The perfectly leveled detail plan of Madrid is worthy of commendation.

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157. **José Julio Rodrigues, Lisbon, Portugal.**

GEOGRAPHICAL MAPS.

Report.—These maps are printed by a photo-typographic and lithographic process. They are remarkable for the precision of the printing and the correctness of the scale.

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158. **Government of New South Wales, Australia.**

MAPS OF NEW SOUTH WALES.

Report.—Commended for the plain way in which the various features of the country, agricultural, mineral, etc., are delineated.

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159. **Pennsylvania Geological Survey Commission, U. S.**

GEOLOGICAL CHARTS, RELIEVOS, AND PROFILES (PENNSYLVANIA).

Report.—Works executed with the greatest perfection, and giving a complete idea of the coal veins, iron mines, and others of great importance.

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160. **Pennsylvania Geological Survey Commission, U. S.**

GEOLOGICAL MAP IN RELIEF (PENNSYLVANIA).

Report.—The works exhibited by the Survey Commission of Pennsylvania contain different geological charts in relief and profiles, giving a complete idea of the formation of different basins of coal, and of other localities where other formations are more interesting. An interesting collection of samples completes this exhibition, which merits the greatest consideration by its scientific interest.

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161. **Kentucky Survey Commission, U. S.**

GEOLOGICAL CHARTS AND PROFILES (KENTUCKY).

Report.—These works are extensive and complete. The charts, made with the greatest skill, show all the geological information of the soil. The drawings are perfect.

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162. **M. Wallez, Architect, Paris, France.**

VENTILATION OF GLAZED COURT OF THE LABORATORY OF THE SCHOOL OF MINES, PARIS.

Report.—Commended for the ability shown in securing a thorough ventilation, elegance, and simplicity.

163. Government of Chili.

TOPOGRAPHICAL CHARTS.

Report.—Commended for the great collection of charts presented by the Government of Chili, embracing the whole State, including its coast. Generally well made. These works commend the Government of Chili, and show how much it is interested in the development of commerce and industry generally.

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164. Ministry of Public Works, Paris, France.

PUBLIC WORKS OF FRANCE.

Report.—This is a most carefully arranged and extensive exhibit, relating to important works of every class, as executed in different parts of the country. It includes maps, plans, models, photographs, apparatus, etc., illustrating the systems and processes employed in the whole range of engineering works. It is needless, in view of the high state of the engineering art in France, to say more than that this display does great credit even to the source whence it comes.

PUMPING MACHINES FOR THE SUPPLY OF THE CANAL BETWEEN AISNE AND MARNE, AT CONDÉ-SUR-MARNE.

Report.—The canal between the rivers Aisne and Marne, connecting the iron ore basin of St. Dizier with the Belgian collieries, runs across very permeable strata. It has been necessary to give it an impermeable lining, and to take the water supply required for navigation from the river Marne by means of pumps worked by water power. The apparatus consists of five Koechlin turbines driving double-acting pumps. These pumps have valves of a novel construction, very remarkable for their excellence of arrangement. Seven years' successful working has fully attested the perfection of the system and of its manner of execution. The water supply has been ample for a traffic of four hundred thousand francs per year.

DRAWINGS OF ARMEN LIGHT-HOUSE.

Report.—The construction of the Armen light-house is one of the most daring enterprises ever conceived and executed for the safety of navigation and for the benefit of humanity, as it is erected over one of the most dangerous reefs of the Armorican coasts, where even landing had been deemed almost impossible, on account of the violence of the currents and of the continuous breaking of the waves.

It does the greatest honor to the engineers and to all the workmen engaged in the construction, whose courage and energy have secured the completion of this audacious work.

MODELS AND DESIGNS CONCERNING THE RIVER YONNE WEIR AT "LA BRULÉE."

Report.—The securing of a permanent navigation of the river Yonne, which had previously been subject to great interruption, offers one of the best examples of the advantages of falling-top shutters, invented and improved by French engineers. The same exhibits illustrate also the raising of the shutters by hydraulic power, as practiced at the dam of "La Brulée," the power being furnished by the water-fall itself.

MODELS AND DESIGNS DESCRIBING THE MOVABLE WEIRS OF THE UPPER SEINE.

Report.—The construction of movable weirs with navigable passes on the Upper Seine has been very successful in the improvement of navigation by new systems of automatic wickets and of frames specially adapted to high lifts.

DESIGNS CONCERNING THE PORT OF HAVRE, CITADEL BASIN.

Report.—These exhibits consist of a basin with two locks, three dry-docks, two swinging bridges, and a set of flushing gates.

It would be difficult to find a more complete collection of hydraulic works, or one whose planning and execution better satisfy all the requirements of maritime traffic, and which gives evidence of more thorough study and skillful engineering.

DESIGNS CONCERNING BAYONNE HARBOR.

Report.—The improvement of Bayonne harbor at the mouth of Adour River, which is obstructed by a drift-bar, has been secured by the construction of open jetties, for which iron tubes have been sunk to a great depth into the sand by pneumatic apparatus. The details of construction, as well as the general scheme, are of great interest, and deserve to be commended as a valuable contribution to the art of civil engineering.

DESIGNS CONCERNING THE IMPROVEMENT OF THE "SEINE MARITIME."

Report.—The results procured on Lower Seine, between Havre and Rouen, by which navigation has been greatly improved and a vast extent of low lands reclaimed, constitute one of the most interesting illustrations of the system of parallel embankments applied to the improvement of rivers. They are well worthy of the study of all engineers in charge of such works.

MODEL OF A WEIR WITH FALLING SHUTTERS, ON THE RIVER MARNE.

Report.—The system of movable wickets, as represented by the model, and first applied to the canalization of the river Marne, is one of the most valuable inventions in hydraulic engineering, and it is of the greatest utility in the improvement of rivers, its efficiency and perfection of working having been sufficiently tested by the experience of the past eighteen years.

MODEL OF A DAM AND SIPHON WEIR AT THE MITTERSHEIM RESERVOIR.

Report.—The reservoir at Mittersheim, constructed in order to supply a part of the Seine collieries canal, is intended to contain seven million cubic meters, and to operate under such conditions that the capacity of the water-fall could never be exceeded. The reservoir dam is conspicuous for its excellence of execution. The level-regulating automatic apparatus, consisting of two siphons governed by two smaller ones, is very ingenious, and does great credit to its author.

PERSPECTIVE VIEW OF ST. NAZAIRE HARBOR, AND MODELS.

Report.—The port of St. Nazaire, created thirty years ago for the accommodation of transatlantic commerce, is a seaport where the most serious difficulties, not only in construction, but also in maintaining the required draught of water by dredging, have been successfully surmounted by the skill of the engineers in charge of the works.

The models and designs of timber and iron gates for locks, twenty-five meters wide, ten meters high, are very remarkable for their good arrangement and execution.

MODEL OF CANAL BRIDGE OVER THE RIVER ALBE.

Report.—The model exhibited represents a part of an iron canal bridge built over the river Albe. The arrangement of the iron-framed basin, and the means by which at the junction with the masonry the leaks are obviated, are very remarkable.

DESIGNS RELATING TO THE NEW BASINS OF THE PORT OF BORDEAUX.

Report.—The port of Bordeaux, whose increasing traffic required new accommodations, has been recently enlarged by a basin covering an area of ten hectares, with a draught of water of $7\frac{30}{100}$ meters. It communicates with the Garonne by two locks respectively fourteen meters and twenty-two meters wide. The construction of these works has given an opportunity to apply on the largest scale yet known the system of constructing foundations by sinking hollow columns of masonry,—a system especially appropriate to the local conditions at Bordeaux,—and to adapt it by novel means to work at great depths carried out in spite of very serious difficulties.

LIGHT-HOUSE APPARATUS OF THE SECOND ORDER, REPRESENTED BY DESIGNS AND PANELS.

Report.—This apparatus consists of a fixed light with flashes every four minutes; two opposed sectors, illuminating one-eighth of the horizon, are replaced by complete annular lenses, and it revolves once in eight minutes. This apparatus presents several new features, viz., in regard to the adaptation of the dioptrical profile with the catadioptrical, to the greater vertical range of the dioptrical lenses, to the arrangement of the frame, and to the arrangement of the lamp valves. It deserves to be considered a valuable contribution to the improvement of light-houses.

MODELS OF A SWINGING BRIDGE AT BREST.

Report.—This swinging bridge, thrown over the river Penfeld, between Brest and Recoussance, has the largest free span in the world, the span between the piers being about one hundred and six meters. The conception of this daring work, as well as the accurate execution of all its details, makes it very conspicuous, and bears evidence to the ability and skill of the engineers who planned and executed it.

DRAWINGS OF A LIGHT-HOUSE AT LE FOUR.

Report.—This light-house has been recently erected on the most projecting rock off d'Argenton harbor, where, during heavy gales, the waves very often break over the top of the building. The constant roughness of the sea and the unfavorable slope of the water where the building was founded necessitated special arrangements in laying the foundations. A novel cuticular apparatus has been adapted to this light-house, which is provided with a fog signal invented by Professor Lissajoux, which is worked by steam. The numerous inventions and improvements first executed in this light-house make it very remarkable.

MODELS RELATING TO THE DAM AND RESERVOIR OF FURENS FOR THE WATER SUPPLY OF ST. ETIENNE.

Report.—This is a combination of very important hydraulic works, undertaken within the past few years for the purpose of protecting the thrifty town of St. Etienne against inundation, and providing it with a water supply for public use and for furnishing power for the numerous manufactures of the city. The most prominent work is a reservoir fifty meters high, and containing one million two hundred thousand cubic meters, where the flood-waters of the river Furens are stored, and whence the regular water supply is delivered by a system of aqueducts, valves, etc. The importance of the works, the accuracy of their planning and execution, commend them for study as a most valuable contribution to the art of civil engineering.

MODELS OF LIGHT-HOUSES AND LIGHT-HOUSE APPARATUS—BUOYS AND BEACONS, LAMPS AND UTENSILS.

Report.—The French "Administration centrale des Phares," to which all nations are

much indebted for the improvement of light-houses, and which has kept, up to the present time, the first place in this respect, has sent to the Exhibition:

1. Several models and drawings for light-houses, buoys, and beacons.
2. Several examples of novel apparatus.
3. A collection of lamps and utensils for light-houses, together with copies of reports and regulations concerning them.

This exhibit is of the highest interest, and bears witness to the continuous efforts made by the French Administration to introduce in the management of light-houses all scientific improvements, and to meet all the requirements of the public service.

COLLECTION OF LAMPS FOR THE USE OF MINERAL OIL IN LIGHT-HOUSES.

Report.—A great progress has been secured in French light-houses by the substitution of mineral oil for vegetable oil. The first lamp for mineral oil, invented by Captain Doty, of the United States, has been greatly improved by the French Administration. It has been adapted to the largest lamps by a special apparatus acting as a regulator. The expense saved by the use of mineral oil being not less than thirty per cent., while the increase of light is more than sixty-six per cent., the example of the French Administration in extending the use of mineral oil to almost all light-houses, and rendering it very easy and safe, is most instructive.

DRAWINGS CONCERNING THE ST. LOUIS CANAL.

Report.—The obstruction at the mouth of the Rhone has been obviated by the construction of a direct canal, three thousand three hundred meters long, six meters deep, communicating at Port St. Louis with the sea by a lock twenty-two meters wide.

The designs concerning this canal are very interesting, not only as an illustration of the canal system for the improvement of river mouths, but also on account of the remarkable planning and construction of the terminal lock and jetties, and the arrangement and execution of the lock gates.

LIGHT-HOUSE APPARATUS FOR ELECTRICAL LIGHT.

Report.—This special apparatus for electrical light is so arranged as to produce a light with eclipses every thirty seconds, and consists of a fixed light illuminating three-quarters of the horizon, with a revolving drum formed of sixteen vertical lenses.

The novel arrangements for increasing the angular range of the profile and for making the light visible at a short distance, as well as the perfection of the workmanship, are of great value and merit.

APPARATUS FOR PROVISIONAL LIGHT-HOUSES.

Report.—The apparatus exhibited is intended to be employed as a substitute in cases of repair, or provisionally, pending the erection of a permanent apparatus. It consists of a fixed light, illuminating three-quarters of the horizon, and of a drum composed of eight vertical lenses, revolved by clock work contained in the apparatus. This novel apparatus might be of great utility, as it is not bulky, and it may be made to produce, by ingenious combinations, white or colored light, with eclipses or flashes, and to revolve at three different rates of speed.

DRAWINGS CONCERNING A PNEUMATIC CAISSON FOR THE PORT OF BREST.

Report.—The rebuilding of the oldest basin in the port of Brest has given occasion for a new application of the pneumatic system in sinking a caisson to serve as a coffer-dam at the entrance to the basin; this caisson was 27 m. long, $8\frac{50}{100}$ m. wide, and $10\frac{60}{100}$ m. high.

The size of the caisson and the difficulties encountered in the sinking and in the demolishing of the provisional part of the work give a special interest to these drawings, and make the description of all the operations very interesting.

STONE BRIDGE AND VIADUCT AT POINT DU JOUR, NEAR PARIS.

Report.—One of the most prominent masonry works recently executed in France is the bridge viaduct built over the Seine, near Paris, at Point du Jour, for the Ceinture Railway. This work consists of a bridge, including an upper floor for railway traffic and an under one for a carriage way, and of a railway viaduct in continuation of the bridge. The under part of the bridge is formed of five elliptical arches thirty meters span and nine meters high; its width is thirty-one meters; the upper part has thirty-one circular arches of $4\frac{40}{100}$ meters span rising to a height of nine meters over the former, and nine meters wide. The viaduct, one hundred and fifty-four meters long, is composed of arches of about the same span, and fourteen meters wide. For excellence of planning, accuracy of execution, elegance of proportion, this double work deserves to be considered as a model of bridge architecture.

MODEL OF A VIADUCT AT PORT LANNAY.

Report.—The viaduct at Port Lannay, on the Chateaulin-Brest Railway, crosses a part of the river Aulin which is used for maritime navigation. It has twenty-two arches of twenty-two meters span and $52\frac{84}{100}$ meters above mean high water. This viaduct of masonry is of very daring proportions and of much elegance. It does great credit to the ability and skill of the engineers who have planned and executed it.

IRON VIADUCT AT LA BOUBLE.

Report.—The connecting Gaunat railway crosses the Bouble River by an iron viaduct sixty-six meters above low water, and supported by five iron piers, the span between piers being fifty meters. The piers consist of five cast-iron columns tied together in a pyramidal shape, giving a direct support to the frame-work of the lattice trusses of the bridge. This work is one of the best examples of iron viaducts, being very light, elegant, and economical, and it does great credit to the ability of the engineers.

DRAWINGS OF THE NEW DEPOT OF THE ORLEANS RAILWAY IN PARIS.

Report.—The great increase of traffic has induced the Orleans Railway Company to rebuild, on a larger scale, its passenger depot in Paris. The new roofed hall is two hundred and eighty meters long and fifty-one meters wide; the whole covered area is of ten hectares. For excellence of its planning and architectural style this new depot is conspicuous; the means by which it has been constructed without interfering with the traffic are worthy of special attention.

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165. Ministry of Public Works, De Dartein Architect, Paris, France.

FRENCH PAVILION FOR EXHIBITION OF PUBLIC WORKS.

Report.—Commended for appropriate fitness of design and thorough artistic execution.

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166. U. S. Geological Survey of the Territories,—Dr. F. V. Hayden, in charge of first division, Major J. W. Powell, in charge of second division.

GEOLOGICAL MAPS, MODELS, AND PHOTOGRAPHS.

Report.—Commended for finely detailed execution of geological maps of various regions, including Colorado, Uinta Mountains, and Rocky Mountains.

For excellent geological models of Utah, Arizona, and the Elk Mountains.

Also for fossil models.

Also for a collection of photographs, very interesting in a geological point of view, and of great historical interest, concerning prehistoric man.

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167. U. S. Geological Survey of the Territories, Hayden's division (W. H. Holmes & W. H. Jackson, constructors), Washington, D. C., U. S.

MODELS OF CAVE AND CLIFF DWELLINGS, AND POTTERY.

Report.—Commended for the very interesting and instructive exhibit relating to the cliff villages, cave dwellings, and mounds in the West.

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168. Engineer Corps United States Army, Washington, D. C., U. S.

PONTOON BRIDGE FOR ADVANCED GUARD AND MAIN BODY.

Report.—Commended for the lightness and ease of manipulation of the advanced guard pontoon train, causing the movements of the front of an army to be more facile, and making it independent of the main body.

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169. Engineer Department United States Army (Lieutenant Geo. M. Wheeler, in charge), Washington, D. C., U. S.

REPORTS AND MAPS OF SURVEYS AND EXPLORATIONS OF VARIOUS PARTS OF THE UNITED STATES, AND MILITARY MAPS.

Report.—They indicate great ability in organization in wild and desert countries, accuracy of observation, diligent research, and good execution.

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170. U. S. Interior Department, Washington, D. C., U. S.

STATISTICAL MAPS.

Report.—Commended for the beauty of execution, and the ease with which the information required can be obtained from the maps.

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171. United States Coast Survey, Washington, D. C., U. S.

MAPS, REPORTS, CHARTS, INSTRUMENTS, AND IMPLEMENTS.

Report.—The maps, etc., show great beauty of execution in engraving and drawing, and are fully up to the exhibits of the other nations.

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172. Engineer Department, United States Army, Washington, D. C., U. S.

MAPS AND CHARTS OF THE SURVEY OF THE LAKES.

Report.—Commended for excellence of drawing and engraving and general high quality of the work and skill of triangulation, being in all respects up to other surveys of coasts on exhibition.

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173. The Signal Service, United States Army, Washington, D. C., U. S.

METEOROLOGICAL MAPS.

Report.—Commended for the facility with which the required information is obtained from the maps, cheapness of execution rendering them accessible to all at a small price.

174. The Government of the United States.

ENGINEERING EXHIBITS.

Report.—The Government has exhibited some useful and instructive models, drawings, and illustrations of public works appertaining to seas, rivers, and harbors. Among them are specimens of its light-houses and lenses, of piers and breakwaters, and of methods of construction much used and almost peculiar to the United States, such as the crib work, etc.

Model of the Subterranean Excavation at Hallett's Point.

Removing shoals and rocks under water by blasting and dredging in the ordinary way is not uncommon, and large expenditure is frequently incurred for this purpose; but the method adopted for the removal of the submerged reef at Hallett's Point, Hell Gate, New York, by subterranean excavation and by afterwards blasting away the undermined crust, is remarkable for its originality and boldness. Works in charge of Major John Newton, U.S.A.

Model of an Apron or Mattress used for Deflecting the River Current at New Inlet, Cape Fear River, N. C.

Mattresses, or sinkstuck, as they are there called, are extensively applied in Holland for similar purposes; but they are made of more flexible materials, there easily attainable, and more resemble wicker work. The mattresses used at Cape Fear are useful as showing the modification necessitated by a difference of material. Work in charge of Major William P. Craighill, U.S.A.

Gabions used in the Improvement of the Entrance at Galveston Harbor, Texas.

Concrete blocks are usually formed in wooden boxes with movable ends and sides, but these call for carpenters' and smiths' work. The wicker gabions dispense with that kind of labor, and are an illustration of adapting methods of construction to the means at hand. Works under the direction of Captain Howell, U.S.A.

Steam Drilling Scow with Dome.

The cast-iron dome facilitates drilling holes for blasting rocks under water, and also serves to protect the divers against currents, and is a well-designed, novel, and useful adjunct to those who have to execute work under water. Designed by General John Newton, U.S.A.

Model of Dredge Boat "McAllister," used in Improving the Mouth of the Mississippi River.

The principle adopted in its construction is to use a very powerful screw to propel the vessel, and at the same time to disperse the weed raked up by the scraper following immediately in the wake of the vessel, and so arranged as to be capable of adjustment to different angles of obliquity. Submitted by Captain Howell, U.S.A.

United States Snag Boat "J. N. Macomb."

This is a well-designed and powerful vessel, furnished with ample and useful contrivances to enable it to accomplish its work.

Built under the direction of Major Charles R. Suter, U.S.A.

Details of pumping apparatus "Henry Barden," for lifting and holding sand in lieu of ordinary dredges.

Raising sand by pumping, instead of by dredging in the ordinary way, has been successfully carried on for some time on the Amsterdam sea canal.

This machine, which is designed for the same purpose, is in a somewhat different but useful form.

Designed by General Gillmore, U.S.A.

Model of Minot's Ledge Light-House, Entrance to Boston Bay.

This is a good specimen of a light-house, built of granite, ninety-two feet high, and standing in twelve feet of water at high tide. Its base is built solid for a considerable height, and the lower courses of stone are banded by a system of dovetailing differing from that adopted by Smeaton at the Eddystone or by Stevenson at the Bell Rock, but it seems as effective.

Lens of second order, visible sixteen miles; fog bell struck by machinery.

Model of Iron Screw Pile Light-House, Florida Reef.

First order lens, visible eighteen miles, light scintillating every five seconds, flashing red every sixth second.

Model of Iron Screw Pile Light-House on Brandywine Shoal, Delaware Bay.

Lens third order. Fog signal bell struck seven blows at intervals of six seconds, then a pause of thirty seconds.

Model of an Iron Light-House on Sombrero Shoal, Florida Reef.

Built of iron columns standing on iron disks resting on a coral foundation.

Lens of first order, light fixed, white.

Light-House at Southwest Pass, Mississippi River.

Constructed of iron columns standing on a stone base, the masonry being built in a wooden crib.

Model of Spectacle Reef Stone Light-House, Lake Michigan.

The model shows method of construction, which was by using a coffer dam within a wooden crib.

Range of light sixteen and three-quarter miles, alternate red and white; a ten-inch steam fog whistle.

Light-House Iron Tower on North Pier of Chicago Harbor.

Third order lens, eighty-three feet high, visible sixteen miles, fixed white light.

These light-houses are all good specimens of their kind. Exhibited with the models of the light-houses are fine specimens of lenses of the first, third, fourth, and fifth orders. The lens of the first order, white, flashing every ten seconds.

Model of the United States Iron Shipping and Landing Pier, Delaware Breakwater.

Constructed of iron screw piles, in a soft bottom of sand and mud.

Engineer, Lieutenant-Colonel Kurtz, U.S.A.

Harbor of Refuge, Lake Huron.

This is a work of considerable magnitude, having a breakwater seven thousand feet long, and an arc of twelve feet of water of three hundred and twenty acres.

The breakwater constructed of crib work.

Engineer, Major Weitzell, U.S.A.

A Model of the Crib Work used in constructing the Breakwater in Oswego Harbor, Lake Ontario.

Engineer, John M. Wilson, U.S.A.

A Model of the Crib Work used in constructing the U.S. Breakwater at Dunkirk, N. Y., Lake Erie.

Colonel C. E. Blunt, for Major F. Harwood, U.S.A.

175. **Gen. M. C. Meigs, U.S.A., Washington Aqueduct, Washington, D. C., U. S.**

PLANS OF TWO LARGE BRIDGES, ONE OF STONE, THE OTHER OF IRON.

Report.—The stone bridge has a span of two hundred and twenty feet and a rise of fifty-six and a quarter feet. It is a good engineering work, and, though built some years ago, is probably now the largest stone arch in existence.

The iron bridge is remarkable for originality and boldness. It has a span of two hundred feet and a rise of twenty-six feet. The segmental ribs which form the arch consist of iron pipes four feet in internal diameter, through which the water flows that supplies the city of Washington; and thus the pipes are made to serve two important purposes, neither of which interferes with the other.

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176. **The Keystone Bridge Co., Philadelphia, Pa., U. S.**

THE ILLINOIS AND ST. LOUIS STEEL ARCHED BRIDGE.

Report.—This bridge is a great engineering work, and presents many engineering details both in design and construction, and is well worthy of study.

It has the largest arches, so far as the writer is aware, that have ever been constructed, having clear spans of five hundred and twenty feet and five hundred and two feet.

The arches are formed of eight cylindrical ribs of steel, connected by cylindrical cross bracings, a full-sized model of a short portion of which is exhibited. The arches carry a double line of railway below, and a roadway above.

The mode of erection is worthy of notice, the portions of the ribs as the work advanced being supported by overhead guys that were passed over temporary towers erected on each pier. By this method of proceeding, all scaffolding centering on supports from below was dispensed with.

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177. **Francis C. Lowthrop, Trenton, N. J., U. S.**

PHOTOGRAPHS OF IRON BRIDGES AND TURN-TABLES, AND OF PLANS OF WROUGHT IRON BRIDGES, AND MODELS OF DETAILS.

Report.—The photographs and models exhibit bridge work useful in form and design, and a good method of construction of the live ring for swing or pivot bridges. This engineer has in many cases made the parts of his bridges under compression of cast iron, using wrought iron for those parts subject to extension, a method which has been adopted in many cases in Europe. But it is now much less used than formerly, engineers generally preferring to make their trusses wholly of wrought iron. There are, however, in England, bridges in which cast iron is used for compressive strains, over which the heaviest railway traffic has been passing for forty years.

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178. **General William Sooy Smith, Maywood, Cook County, Ill., U. S.**

DESIGNS OF PNEUMATIC CAISSON IN THE STRAITS OF MACKINAC, SURROUNDING WAN-GOOHANCE LIGHT-HOUSE.

Report.—An original design and well adapted to the case to which it was applied, and which appears to have been quite successful in its application. It was used for surrounding and protecting the base of a light-house which was insecure. The light-house was two and a half miles from shore, on a reef open to considerable exposure, and the large caisson used by General W. S. Smith is claimed to be the pioneer work of its kind in the United States.

179. The Fire-Proof Building Co. of New York, New York, N. Y., U. S.

HOLLOW BLOCKS AND HOLLOW BRICKS MADE OF HYDRAULIC LIME OF TEIL.

Report.—Commended for their excellence as a fire-proof material, also for their moderate cost, combining strength, lightness, resistance to fire and water, and advantage of being easily moulded to any pattern. They can be introduced advantageously in floorings, ceilings, furring, partitions, roof-work, etc., and are peculiarly well adapted to wooden structures.

SIGNING JUDGES OF GROUP XXVI.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

R. M. HUNT, 1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 17, 18, 19, 21, 22, 23, 24, 31, 32, 33, 34, 35, 36, 38, 39, 152, 153, 154, 155, 162, 165, 167, 179.

LOURENCO MALHEIRO, 2, 10, 20, 70, 88, 91, 92, 113, 118, 119, 120, 121, 125, 126, 129, 131, 132, 134, 138, 139, 156, 157, 166, 171.

GEO. E. WARING, 15, 27, 37, 40, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 58, 59, 61, 77, 78, 93, 164.

J. G. W. FYNJE, 16, 26, 29, 57, 63, 64, 66, 68, 69, 117.

E. LAVOINNE, 25, 28, 65, 85, 86, 87, 89.

JAS. B. EADS, 30, 71, 76, 79, 84.

WM. B. FRANKLIN, 41, 60, 62, 67, 80, 90, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 115, 124, 127, 130, 133, 135, 136, 137, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 151, 158, 168, 169, 170, 172, 173.

JOHN HAWKSHAW, 72, 73, 74, 75, 81, 82, 174, 175, 176, 177, 178.

J. M. DA S. COUTINHO, 83, 114, 116, 122, 123, 128, 150, 159, 160, 161, 163.

SUPPLEMENT TO GROUP XXVI.

REPORTS

OF

JUDGES ON APPEALS.

JUDGES.

JOHN FRITZ, Bethlehem, Pa.
EDWARD CONLEY, Cincinnati, Ohio.
CHARLES STAPLES, JR., Portland, Me.
BENJ. F. BRITTON, New York City.
H. H. SMITH, Philadelphia, Pa.
COLEMAN SELLERS, Philadelphia, Pa.
JAMES L. CLAGHORN, Philadelphia, Pa.
HENRY K. OLIVER, Salem, Mass.
M. WILKINS, Harrisburg, Oregon.
S. F. BAIRD, Washington, D. C.

1. Garry Iron Roofing Co., Cleveland, Ohio, U. S.

GALVANIZED IRON ROOF ON OHIO STATE BUILDING, SHUTTERS AND CORNICE IN GALVANIZED IRON.

Report.—Commended for good material and workmanship, and fitness for intended use.

2. The American Bridge Co., Chicago, Ill., U. S.

MODEL OF STIFFENED SUSPENSION BRIDGE.

Report.—1. Model exhibited of bridge now being erected at Pittsburg, constructed on the stiffened suspension system, combining elegance in form with economy of construction.

2. Specimen of wrought-iron column. Commended for good design and economical use of material, facility offered for protection of all parts by paint.

3. W. C. Allison & Co., Philadelphia, Pa., U. S.

J. HOSKIN'S SHEET METAL GAUGE.

Report.—Commended for utility, accuracy, and ease of adjustment.

4. Gaetano Canelli, Milan, Italy.

PLANS AND ELEVATION OF THEATRE.

Report.—Commended for accuracy and purity of lines in the *ensemble*, classical taste in architectural design, showing also ample provision in hygienic appliances, with freedom for ingress and egress.

5. J. & C. G. Bolinder Machine-Manufacturing Co. (Limited), Stockholm, S~~eden.

ORNAMENTAL CASTINGS OF IRON.

Report.—Copies of shields and repoussé plates cast in iron and finished. Commended for beauty of workmanship and finish. Iron railings in cast iron, of good design and finish.

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6. Inspection-General of Public Works of the Philippine Islands.

PORTFOLIO OF PLANS AND CHARTS OF PUBLIC WORKS OF THE PHILIPPINE ISLANDS.

Report.—Commended for variety and mechanical execution of the illustrations, and the solution of many important engineering problems.

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7. Edge & Sons, Coalport Works, Shipnal, Shropshire, England.

WIRE ROPES AND CHAINS FOR MINING AND ENGINEERING PURPOSES.

Report.—Commended for an exhibit of the above-named articles in many sizes, from quite small to very large, and all of superior excellence.

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8. Cavaliere Fortunato Lodi, Italy.

FOURTEEN PLANS FOR A THEATRE.

Report.—Commended for artistic skill in design and in execution, with completeness of detail in structure.

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9. S. R. Foster, St. John, New Brunswick.

AUTOMATIC FIRE-PROOF SHUTTERS.

Report.—Commended for the protection afforded against fire externally, and for the rapidity with which all the shutters in the building may be closed.

SIGNING JUDGES OF SUPPLEMENT TO GROUP XXVI.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

CHAS. STAPLES, JR., 1, 4, 7, 8, 9.
COLEMAN SELLERS, 2, 3, 5.
SPENCER F. BAIRD, 6.

United States Centennial Commission.

INTERNATIONAL EXHIBITION,

1876.

REPORTS AND AWARDS

GROUP XXVII.

EDITED BY
FRANCIS A. WALKER,
CHIEF OF THE BUREAU OF AWARDS.

PHILADELPHIA:
J. B. LIPPINCOTT & CO.
1877.

SYSTEM OF AWARDS

[*Extract from Circular of April* 8, 1876.]

Awards shall be based upon written reports attested by the signatures of their authors.

The Judges will be selected for their known qualifications and character, and will be experts in departments to which they will be respectively assigned. The foreign members of this body will be appointed by the Commission of each country and in conformity with the distribution and allotment to each, which will be hereafter announced. The Judges from the United States will be appointed by the Centennial Commission.

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Reports and awards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to public wants, economy and cost.

Each report will be delivered to the Centennial Commission as soon as completed, for final award and publication.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress, and will consist of a diploma with a uniform Bronze Medal, and a special report of the Judges on the subject of the Award.

Each exhibitor will have the right to produce and publish the report awarded to him, but the United States Centennial Commission reserves the right to publish and dispose of all reports in the manner it thinks best for public information, and also to embody and distribute the reports as records of the Exhibition.

ORGANIZATION AND DUTIES OF THE JUDGES.

[*Extract from Circular of May* 1, 1876.]

Two hundred and fifty Judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the Groups to which they have been respect ively assigned. The foreign members of this body have been appointed

by the Commission of each country, in conformity with the distribution and allotment to each, adopted by the United States Centennial Commission. The Judges from the United States have been appointed by the Centennial Commission.

To facilitate the examination by the Judges of the articles exhibited, they have been classified in Groups. To each of these Groups a competent number of Judges (Foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the Departments of Agriculture and Horticulture, which will form temporary exhibitions, have been arranged in special Groups, and Judges will be assigned to them hereafter.

The Judges will meet for organization on May 24, at 12 M., at the Judges' Pavilion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

The Judges assigned to each Group will choose from among themselves a Chairman and a Secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a Judge in each Group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed, by a majority of the Judges in such Group.

The reports of the Judges recommending awards based on the standards of merit referred to in the foregoing System of Awards, must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

Awards will be finally decreed by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the Judges on the subject of the Award, together with a Diploma and a uniform Bronze Medal.

Upon matters not submitted for competitive trial, and upon such others as may be named by the Commission, the Judges will prepare reports showing the progress made during the past hundred years.

Vacancies in the corps of Judges will be filled by the authority which made the original appointment.

No exhibitor can be a Judge in the Group in which he exhibits.

An exhibitor, who is not the manufacturer or producer of the article exhibited, shall not be entitled to an award.

The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the Judges. Upon request, he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the Commission relating to awards, subject to an appeal to the Commission.

A. T. GOSHORN,
Director-General.

[*Extract from Director-General's Address to Judges, May 24,* 1876.]

"The method of initiating awards which we have adopted differs in some respects from that pursued in previous exhibitions. In place of the anonymous verdict of a jury, we have substituted the written opinion of a Judge. On this basis awards will carry the weight and guarantees due to individual personal character, ability, and attainments, and to this extent their reliability and value will be increased. It is not expected that you will shower awards indiscriminately upon the products in this vast collection. You may possibly find a large proportion in no way raised above the dead level, nor deserving of particular notice. The standard above which particular merit worthy of distinction begins is for you to determine. In this regard I have only to express the desire of the Centennial Commission, that you should do this with absolute freedom, and when you meet with a product which you consider worthy of an award, we desire you to say, in as few words as you may deem suitable, why you think so.

"This, gentlemen, is all we ask of you in the Departments of Awards. Opinions thus expressed will indicate the inherent and comparative merits, qualities, and adaptations of the products,—information which the public most desires.

"Elaborate general reports and voluminous essays, though of great value as sources of general information, give little aid in determining the reliable or intrinsic merits of particular, individual products.

"The regulations which have been published divide the work of awards into three parts:

"1st. The individual work of the Judges.

"2d. The collective work of the groups of Judges.

"3d. The final decisions of the United States Centennial Commission in conformity with the acts of Congress.

"Each award will thus pass three ordeals, which, doubtless, will be ample and satisfactory."

GROUP XXVII.

JUDGES.

AMERICAN.

Frank H. Smith, Boston, Mass.

James L. Claghorn, Philadelphia, Pa.

John F. Weir, New Haven, Conn.

Brantz Mayer, Baltimore, Md.

Donald G. Mitchell, New Haven, Conn.

George Ward Nichols, Cincinnati, Ohio.

Henry Draper, New York, N. Y.

FOREIGN.

Charles West Cope, Great Britain.

Peter Graham, Great Britain.

Carl Schlesinger, Germany.

Hermann W. Vogel, Germany.

Jules Emile Saintin, France.

Fritz L. von Dardel, Sweden.

P. N. Arbo, Norway.

Count of Donadio, Spain.

Antonio Tantardini, Italy.

Guglielmo De Sanctis, Italy.

Carl Costenoble, Austria.

Jens V. Dahlerup, Denmark.

E. van Heemskerck van Beest, Netherlands.

H. D. Kruseman van Elten, Netherlands.

GROUP XXVII.

PLASTIC AND GRAPHIC ART.

SCULPTURE.

CLASS 400.—Figures and groups in stone, metal, clay, or plaster.

CLASS 401.—Bas-reliefs, in stone or metal; electrotype copies.

CLASS 402.—Medals, pressed and engraved; electrotypes of medals.

CLASS 403.—Hammered and wrought work,—*repoussé* and *rehaussé* work; embossed and engraved relief work.

CLASS 404.—Cameos, intaglios, engraved stones, dies, seals, etc.

CLASS 405.—Carvings in wood, ivory, and metal.

PAINTING.

CLASS 410.—Painting in oil, on canvas, panels, etc.

CLASS 411.—Water-color pictures; aquarelles, miniatures, etc.

CLASS 412.—Frescoes, cartoons for frescoes, etc.

CLASS 413.—Painting with vitrifiable colors. Pictures on porcelain, enamel, and metal.

ENGRAVING AND LITHOGRAPHY.

CLASS 420.—Drawings with pen, pencil, or crayons.

CLASS 421.—Line engravings from steel, copper, or stone.

CLASS 422.—Wood engravings.

CLASS 423.—Lithographs, zincographs, etc.

CLASS 424.—Chromo-lithographs.

PHOTOGRAPHY.

CLASS 430.—Photographs on paper, metal, glass, wood, fabrics, or enamel surfaces. Micro-photographs.

CLASS 431.—Prints from photo-relief plates; carbon-prints, etc.

CLASS 432.—Photo-lithographs, etc.

INDUSTRIAL AND ARCHITECTURAL DESIGNS, MODELS, AND DECORATIONS.

CLASS 440.—Industrial designs.

CLASS 441.—Architectural designs; studies and fragments, representations and projects of edifices; restorations from ruins and from documents.

CLASS 442.—Decoration of interiors of buildings.

CLASS 443.—Artistic hardware and trimmings; artistic castings; forged metal work for decoration, etc.

DECORATION WITH CERAMIC AND VITREOUS MATERIALS; MOSAIC AND INLAID WORK.

CLASS 450.—Mosaic and inlaid work in stone.

CLASS 451.—Mosaic and inlaid work in tiles, tesseræ, glass, etc.

CLASS 452.—Inlaid work in wood and metal; parquetry, inlaid floors, tables, etc.

CLASS 453.—Stained glass.

CLASS 454.—Miscellaneous objects of art.

GENERAL REPORT

OF THE

JUDGES OF GROUP XXVII.

INTERNATIONAL EXHIBITION, 1876.

PROF. F. A. WALKER, *Chief of Bureau of Awards:*

SIR,—I forward, on behalf of the Judges of Group XXVII., their reports upon the Art exhibits in the International Exhibition.

Very respectfully,

JAMES L. CLAGHORN, *Chairman.*

GROUP XXVII.

PLASTIC AND GRAPHIC ART.

PAINTING AND SCULPTURE.

BY JOHN F. WEIR.

No department of the International Exhibition attracted more general attention than that of the Fine Arts, in Memorial Hall and its Annex, nor was any department the subject of more frequent and extended comment in the newspaper press.

This fact is significant; for the marked and general eagerness of the public to view the art-exhibits of the various nations evinced a very decided partiality for the attractions afforded by this display. That this susceptibility to the influence of art exists to a much wider extent with the public than may have been supposed, and that it only awaits opportunity for its proper gratification, is a natural conclusion. Museums and academies of the Fine Arts have become a prominent feature in our larger cities; and with the increase of facilities thus afforded for study and discipline a very earnest and general desire is manifest on the part of the public for a more intimate knowledge of art than has hitherto been possible, except with those who have been able to seek this knowledge abroad.

These institutions, therefore, are not in advance of the general tendencies of the time, or of the wants of the people. The wealth of the nation is gradually insuring that leisure or repose which follows material development, and which is perhaps essential to the promotion of intellectual pursuits. From this source, also, follows the accumulation of works of art that a far-reaching commerce supplies; and the demand for the more mature and refining fruits of civilized life is becoming select and discriminating. Private collections, comprising in many cases the works of the most distinguished living artists, and in some instances their chief productions, are now by no means unfrequent. The recent exhibition at the National Academy and the Metropolitan Museum of Art, in New York, of the selected

works of contemporary art from these private collections, could hardly have been surpassed, within its limits, in any country, in its representative character. Consequently, the art-exhibit at Philadelphia afforded few surprises for which the American public were unprepared, nor did it contribute materially to the knowledge we already possessed, through our own collections, of the present state of the Fine Arts among the different nations of Europe.

But it is through the opportunity for comparison, afforded by International Exhibitions, that the marked peculiarities which distinguish styles and schools of art strike the observer with more than usual force. Their merits and demerits, also, are rendered more conspicuous through this severe and uncompromising test of juxtaposition, where they enter into close competition and fill the eye in rapid succession. Passing from one gallery to another, one is not insensible to some such experience as that of encountering a foreign tongue: every successive impression is in turn dominated by certain characteristic forms of expression peculiar to each nation. Thus it may, in some measure, afford a test of true excellence when it is found that the artist rises above the conventional level of local sympathies and attains the higher plane of sentiments which are general and universal. For art, in its truer forms, is a common language, requiring no other interpretation than that derived from its own inherent powers of expression. Time and distinctions of race are obliterated in its universal aim. When, therefore, the art of any people appears to require some special explanation by reason of its local character or the fashion of a time or place, we may conclude that it is so far mannered or conventional, and consequently inartistic.

In discussing the merits and characteristics of the art-exhibits of the different nations, it is but proper to view them with sympathy, so far as this is consistent with those principles upon which sound judgment is based. It is proper, also, to abstain from that narrow notion of applying a standard of estimate which is derived from a decided predilection for some one form of excellence in art to the exclusion of others. This is a common error in criticism, and one to which national prejudices are apt to contribute. It is quite possible for even the more honest and unsuspecting to be sometimes unconsciously swayed by certain unwarranted preferences, from the influences of which they cannot escape; for art is pre-eminently a question of impulse and feeling, and when these are undisciplined or enlisted in some earnest and concentrated end it is not generally conducive to wide likings. But it should be remembered that as art has manifold forms of excel-

lence which are rarely united, and then only in the works of very exceptional genius, these forms of excellence vary in all times and countries with the talents displayed in their manifestations.

The following table will show what nations participated in the Exhibition, and to what extent:

Nations.	Oil-Paintings.	Paintings in Water-Colors.	Sculpture.
1. England	193	54	14
2. France	302	105	73
3. Austria	123	26	8
4. Germany	145	12	12
5. Belgium	173	3	32
6. Netherlands	160	......	1
7. Spain	141	2	23
8. Italy	126	......	325
9. Russia	63	2	8
10. Denmark	15	......	......
11. Sweden	69	11	2
12. Norway	52	......	5
13. Canada	156	......	......
14. Argentine Republic	34	......	......
15. Brazil	10	3	5
16. Mexico	45	......	5
17. United States	760	186	162
Total	2567	404	675

Number of galleries and halls, 71.

GREAT BRITAIN.

The exhibit of Great Britain in painting was very complete and satisfactory. Manifestly the desire was to show not merely the present condition and progress of her art to the best advantage, but, by a liberal contribution of the works of many of her deceased artists, the property of the Royal Academy, to express, as well, a generous interest in the success of the International Exhibition of 1876. This friendly disposition deserved, and received, a most hearty recognition on the part of the people of the United States.

In discussing the merits and characteristics of English art we are naturally led to consider English sentiment and character as manifested in this form of expression; for it may be accepted as a self-evident truth that the art of a nation is a true exponent of the habits of mind and feeling peculiar to that people. And certainly English art is strikingly illustrative of this fact. No such marked contrast is afforded by the art of other countries as that which subsists between France and England. English art is formed by moral ideas, and the subject or story is accorded an importance that is not usually recognized in French art: the emphasis of the latter school is given to treatment rather than to subject, and this distinction lies at the root of the developments in the art of these nations.

The leading sentiment in the art of any people is not peculiar to one form of expression; it pervades all; and their literary issues will be found to be of a similar character with those which distinguish their art. From this fact there arises an important consideration respecting the value of International Exhibitions in promoting a knowledge of the more subtile phases of thought and feeling peculiar to each nation; and these Exhibitions not only enable us to distinguish points of difference, but they also serve to show wherein the nations lose their individuality, in a measure, in the common aims of broader and more profound views of art. English art-criticism is quite distinct from that of Germany or France. It is not without its prejudices, but these are not more marked, as a general thing, than are those of the other countries: the distinction in this respect is one of kind rather than degree. It has been observed with clearness by a recent English writer that "the poles between which æsthetic criticism has always oscillated, and will continue to oscillate, are those of Form and Expression,—the objective and the subjective truths involved in art, as in every other production of the human mind;" and French and English art are, in a measure, representative of these two fundamental ideas, which it is well to harmonize, and which are found united in truly great works of art. This exceptional and proper union may be met with in some of the pictures of the English collection; and it is from them we derive a most favorable impression of what is really excellent as well as characteristic in English art. As a general thing, its character is exclusive and affected by insular tastes. This has been partially modified, and we find occasional evidence of outside influences affecting the traditional methods of this school.

Passing in review the English exhibit of oil-paintings, the impression made by the collection, as a whole, is that of lack of technical grasp. The methods are, for the most part, thin and stained in appearance, and the coloring tawny and monotonous. But in delicacy of sentiment, in the expression of ideas and emotions, and in the pure and poetic feeling manifested in many of the pictures, they possess much that demands the highest praise.

"The Summer Moon" and "Interior of a Jew's House," by Mr. Leighton, are works deserving of special commendation. The former is exquisitely poetic in sentiment, rich and suggestive in tone, and admirable in grace of composition. The "Interior of a Jew's House" is a complete poem from the ancient world. The title is somewhat ambiguous, as it furnishes no clue to the picture, which has the character of ancient Greek civilization in sentiment and surroundings. The figures are painted with rare skill and grace, the drawing is

admirable, and the archæological learning—which seems to be a matter of special pride in art to-day—is most thorough. Few pictures are equally fine in sentiment, and at the same time so thoroughly well rendered with technical skill, as these by Mr. Leighton.

"The Vintage Festival," "The Convalescent," and "The Mummy," by Mr. Alma Taděma,—who, though a Belgian, is classed of late with the English school by reason of his residence in London,—are in a somewhat similar vein, yet with entirely distinct individuality in treatment. In their technical qualities these pictures are no less admirable than for their learning and beautiful conception. It may be said, advisedly, that no pictures of the present day exhibit more thorough qualities of excellence than those by Mr. Taděma. Though, for the most part, Greek and Roman antiquity are the sources from which the inspirations of his art are derived, Mr. Taděma's pictures, as works of art, are never sacrificed to the mere pedantic display of skill and learning. Archæology and brilliant *technique* are features prominently displayed in contemporary art, and to a degree that may perhaps be regarded as dangerously subversive of truer aims,—the emotional, the thoughtful, the expressive,—which render art something more than mere manifestations of learned research, skill, or manual dexterity; and it is agreeable to find that in the works of Mr. Leighton and Mr. Taděma they are properly subordinated to these higher aims.

"Trawlers Waiting for the Darkness," by Mr. Hunter, is a picture of very exceptional power, both in sentiment and in the admirable vigor of its treatment. The breezy expanse of sea at twilight, and the fishermen resting in the boat, are rendered with great truth. The picture is full of the solemnity of the hour and of nature.

"God-speed," by Mr. Boughton, though in many respects representative of the excellent qualities of his art, is not thoroughly satisfactory. The composition is scattered and broken into episodes, and the sentiment a little strained. Mr. Boughton is better represented in the exhibit of the United States, where he is claimed as a fellow-countryman by birth. His "New England Puritans going to Church" and "Going to seek his Fortune" are more satisfactory compositions. The sources from which this artist draws his best inspirations are Chaucer and our Puritan forefathers; and no one has entered more thoroughly into the spirit of the time and the customs thus respectively derived, and with a more genuine sympathy, than Mr. Boughton.

"The Lord gave, and the Lord hath taken away," by Mr. Holl, though painful in subject, is rendered with great delicacy and pathos. The expression of sorrow which pervades the figures and fills the

place where death has left a void as with an atmosphere oppressively sad and afflicting, is wrought out with great power and truth. The picture manifests a most penetrating insight of heart-rending grief, yet so delicately and sympathetically depicted that, while we condemn the choice of subject as too painful, we cannot but admire the consummate skill of the artist evinced in this remarkable work. "Betty," by Mr. S. L. Fildes, is fresh and animated, well drawn, full of spirit and hearty grace. It proved one of the most attractive pictures of the Exhibition. Mr. Fildes' "Applicants for Admission to a Casual Ward" is a subject no less painful than that chosen by Mr. Holl. It is, however, a work of great power, and abounds in admirable individualization of character. But it is in such pictures that we find the tendencies of the English school, in moral aim, perhaps carried to excess. It is a question open for discussion how far the artist may venture in depicting human suffering to accomplish strictly moral ends without endangering the distinctive æsthetic character of art, which is calculated to elevate rather than depress human feeling. This may be effected through sentiment expressed in a minor key; but should there not be a vista of hope through which we may discern some alleviating power at work, which leaves the sensibility in a less morbid state? Even in the tragic drama the feeling of horror and dismay is properly surmounted by sentiments of a loftier and more triumphant character, that redeem the depression and the pain which would otherwise plunge the spectator into a most unhappy mood. He leaves the play, therefore, with his sensibilities gratified, and his emotions are, on the whole, pleasurable. But the very nature of painting, from its immobile character, precludes a similar movement of the moral action in scenes like this depicted by Mr. Fildes. They remain, therefore, transfixed, painful moral lessons rather than true works of art. If the end sought is purely moral, painting is not a legitimate means for its accomplishment, for its manifestations outlive the occasion and become too distressing for permanent contemplation. We do not question the rare skill and profound observation of character evinced in these pictures by Mr. Holl and Mr. Fildes, but we cannot but think their choice of subjects would have been better suited to less labored and less enduring forms of art.

"Circe and the Companions of Ulysses," by Mr. B. Rivière, is conceived and executed with that rare skill which deservedly entitles this artist to the high reputation he enjoys. The humor is admirably rendered, and exhibits a keen appreciation of the possibilities of expression in swinish physiognomy. "The Sick Child," by Mr. J. Clark, is pathetic and tender in feeling,—a sincere representation of

that true touch of nature which makes the whole world kin. Few pictures of the English school evince more admirable qualities than this by Mr. Clark. "Baith Faither and Mither," by Mr. Faed,—who has done for Scottish art what Burns has done for Scottish song,—is thoroughly characteristic of that phase of the British school which is perhaps the most widely popular, and with which its public are most sympathetic. The story of this "mitherless bairn," who, about to set out for school, turns to her father for some little assistance required in her dress, is told with very tender pathos. It is the translation into painting of a subject suited to a poem. It is illustrative and readable, and in technical merit of a certain kind it is in many respects admirable. It is rather poetic than artistic, if the distinction explains itself. The conspicuous values are in the telling of the story rather than in the pictorial treatment.

In portrait-painting, the most notable examples of the English collection are Mr. Watts' portrait of Millais; portrait of a Lady, by Mr. Perugini; Hon. W. E. Forster, by Mr. Wells; "The Three Sisters," by Mr. Archer; and Earl Russell, by Sir Francis Grant. Mr. Watts' head is cleverly painted, unconventional, and spirited. Mr. Perugini's is delicate, sensitive, and refined. Mr. Holman Hunt exhibits a portrait of himself which is rather curious than pleasing. It is thoughtful and serious, as Mr. Hunt's work always is; but the coloring is disagreeable. It is to be regretted that this artist was not more adequately represented: certainly no pictures would have had greater interest for his many friends in this country than those which have made his name so widely and favorably known. Mr. Millais, also, was by no means properly represented in the single portrait-sketch which bore his name. Considering the prominence of these artists, and the very decided originality of their styles, the British collection suffered a serious omission in the absence of characteristic examples of their work. It cannot be said, in reviewing English portrait-painting in the collection at Philadelphia, that we discover in recent work, even remotely, those qualities of excellence evinced in Reynolds' portrait of himself, loaned by the Royal Academy. This portrait is something more than the mere likeness of an extraordinary man; and postrait-painting, to be of interest to the world at large, must have a far higher aim than that of securing a likeness. The portraits of Reynolds and Gainsborough were signally typical of a noble and aristocratic race. Time has wrought no decadence in the type, but it certainly has in the art, and English portrait-painters of the last century preserve a prestige which overshadows their successors of the present day. This may be partially

accounted for by the fact that the most talented artists of this school are now altogether absorbed in *genre*.

The two pictures by the late Sir Edwin Landseer, loaned by Lord Northbrook, were specially valuable as illustrating the change of manner—or rather the transition of manner into style—in this artist's work. "The Traveled Monkey," which evidently is an early picture, is one of a series that was etched in Landseer's "Monkeyana," published many years since. The method is hard and dry, and, on the whole, very old-fashioned, but it is not lacking in character, for which his pictures were always remarkable. The later work, "The Sick Monkey," is something more than this: it is rich in color, admirable in technical dexterity, broad and simple in composition. Mr. Frith's "Pamela" is attractive and pleasing, but his "Railway Station" did not gain the attention here that it did in England. Sentiment is preferred to a mere fact, where this latter is an affair of every-day occurrence, and related to our practical needs; and Mr. Fildes' "Betty" had its throng of admirers, while Mr. Frith's picture was somewhat neglected. Mr. Frith understands, on his own ground, that to be popular it is always necessary to get down to the level of popularity. His pictures show an entire lack of mystery; they are crowded with numerous incidents and stories, well told, and calculated to amuse the curious. But this is not art in any high acceptation of the term. The stories once read, we do not return to Mr. Frith's pictures again and again, as we are instinctively drawn by great works of art. His "Marriage of H. R. H. the Prince of Wales" was an object of interest to a continuous throng of spectators, for the reason that whatever pertains to England's sovereign is always a subject of interest, and even affection, to the people of the United States.

Mr. Brett contributed his "Morning among the Granite Boulders," which is in part admirable, particularly in the truth and simplicity of his treatment of the foreground,—an expanse of shore strewn with rocks. The distant sea and sky are painted with less skill, and are crude in color; but, on the whole, the picture is one of exceptional merit. "After the Battle," and "The Siesta," by Mr. Calderon, are both clever: the former tells its story with very decided interest; the latter is probably a more recent work, evincing greater breadth and freedom in execution. "From under the Sea," by Mr. Hook, is a realistic work of decided power, displaying a strong, vigorous sense of nature. "Celia's Arbor," by Mr. George D. Leslie, is graceful and delicate, though not skillful in its technical qualities. Mr. Poynter's "Ibis Girl" is also a work of decided merit. These pictures are rep-

resentative of those qualities which constitute excellence in English art. The sentiment is rarely sacrificed to mere technical display; on the contrary, the latter is hardly equal to the standard attained by some other painters of this school.

On the whole, the impression made by the British art-exhibit was a decidedly favorable one. English art, as manifested in the best examples sent to Philadelphia, is poetic, pure, and sincere in character. While it sometimes sinks to the level of mere platitude, it is seldom strained, frivolous, or vulgar. As a school, it does not abound in painters of exceptional merit, but its representative artists are not surpassed in those qualities which constitute true excellence, nor are any painters of the present day more learned in the technical requirements of the art.

In landscape-painting the English exhibit gave the impression of a prevailing mannerism that was neither agreeable nor vigorous; but Mr. Hunter's "Trawlers Waiting for the Darkness" is a very marked exception to this criticism, manifesting great individuality. In water-color painting the superiority of the English has been long acknowledged; it is of late, however, very adequately rivaled in France, and perhaps, in some cases, in this country. Messrs. Tadéma, Linton, Jopling, Marks, Callow, and Gilbert were well represented in this branch of art.

The British exhibit in sculpture was slight. The bust of Flaxman, by Bailey, and that of West, by Chantrey, loaned by the Royal Academy, were of interest; and the Venus, by Gibson, is worthy of his reputation; but these are all deceased sculptors. The large terra-cotta group of "America," from the Albert Memorial, by Mr. John Bell, is not without vigor and merit, though decorative in character. At the present time England possesses no sculptors of more than average ability, nor is a susceptibility to pure form a national characteristic.

FRANCE.

The exhibit of France in painting and sculpture affords subject for comment, partly on the ground that their art was not fully represented in the Exhibition, as well as in review of the character of the works selected.

France, unquestionably, is the nation which fills the most conspicuous and the leading position in the art of the present century, and a careful review of the art of that country would embrace, in many particulars, a criticism of the most marked and characteristic tendencies of modern art. In commenting on the various kinds of

excellence that are found united in this school,—if, indeed, the term "school" finds any proper application in modern art, where such classifications are fast being obliterated,—one is not slow to recognize that this superiority is due to several distinct causes. Passing by those considerations peculiar to the genius of the people, as well as the circumstances that affect the æsthetic temperament most favorably, the simple question of artistic discipline is one which the French have never underrated, if, indeed, the tendency has not been to carry this to excess by allowing technical skill to subvert higher aims in art. The admirable discipline afforded the art-student by the École des Beaux-Arts, and in the private *ateliers* of the most distinguished artists of France, has tended to exalt and maintain this high standard of technical merit. An attractive and prevailing excellence of *technique* is certainly commendable in an art so difficult and complex as that of painting, but it is on higher grounds than this that the critic should estimate those qualities which constitute greatness in art, that give to the picture that charm of expression which enkindles reverie and raises the work of the artist upon a common plane with that of the poet, the philosopher, and, unconsciously, with that of the moralist. France has not a few artists of this stamp whose merit we may estimate fairly by this higher standard, and whose power rests not merely in the skillful handling of the brush or the chisel, but in the intellectual grasp and scope evinced in their art, and in a true poetic instinct which renders all technical display subservient to the expression of ideas and emotions,—which, indeed, is the true function of art. J. François Millet, Couture, and Delacroix were artists of this stamp; and others, now living, might be named who have impressed their individuality no less effectively on contemporary art.

But the exhibit of France at Philadelphia was not even fairly representative of these higher achievements of French art. It affords, therefore, a less inviting subject for comment than if it were an adequate representation of the higher aims of this school. And it would be unjust to pretend that this display was, on the whole, a representative one. But in a more general, though less discriminating, sense, we may consider it typical of many ideas prevailing among French artists at the present time, and as such it is worthy of attentive study. The absence, for the most part, of works of conspicuous originality and merit leaves the *ensemble* of the exhibit to the mannerists who collectively form the school,—for the founders of schools are not to be confounded with the elements that compose their following. We have here, then, very little that has earned for

French art the high reputation it enjoys. It is necessary to observe the above distinction if we would discuss, with any degree of intelligence, questions of artistic merit. Art lives by sincere emotions; its true aim is a thoughtful and expressive one; but when this sincerity, this expression, is subverted by motives and considerations that are entirely foreign to art, its products then become mere objects of commerce: other and distinct ends are sought, and are not to be mistaken for those that are genuine. The absence, therefore, for the most part, of the representative names of this school is the cause of that unfavorable impression left by the exhibit of France at the International Exhibition of 1876.

But it is with pleasure that we turn to those works which partially redeem this unfavorable impression. M. Carolus Duran contributed a fine portrait of Mlle. Croizette, of the Théâtre Français. The young lady is seated on horseback, by the sea-side, and the action is exceedingly spirited and natural. There is, too, an open-aired sense of life and animation pervading the picture which is admirable. The horse is well drawn, and the technical execution is clever and confident. "The Convalescent," by M. Sain, is thoughtful and tender in feeling, and has qualities of true excellence. "The King's Entertainment," by M. Comte, is also very sincere in its aim. The figures are earnestly and seriously engaged, and this in a manner, considering the humorous character of the subject, that is almost irresistible. "The Drawing-School," by M. Trupheine, is a clever sketch rather than a finished work; though, after all, the question of finish is merely a relative one, and, if the intention of the artist is attained, the picture may perhaps be properly termed finished. But M. Trupheine's work has the character of a study made directly from the scene itself; it has therefore the usual marks which distinguish the study from the work of the studio. The former has greater freshness and vivacity, the latter more completeness and finish. M. Pabst contributed "A Bride in Alsace," and M. Coltzman a "Court Scene," which are both commendable, though not strikingly meritorious. In *genre* the pictures of this collection do not impress one favorably. They remind us of better things, done over and over again, and have little earnestness and less individuality. The usual boudoir scenes abound,—slight, superficial nothings, of which the observer soon grows tired, and the cleverness of textual representation fails to redeem the lack of sentiment or thought. In landscape M. Luminais sends his "Gauls returning with their Booty," which is bold, skillful, and decidedly effective. "The Oaks of Grand Moulin," by M. Dumeron, is also clever. M. Japy exhibited "The Valley of the Jura;" M. Renié, "Oc-

tober Snow;" M. Yon, "The River Seine;" and M. Zuber, "Near the Farm." These works evince, to some extent, those excellent qualities that are peculiar to French landscape, but they are not strikingly characteristic, nor of superior merit. But even subordinate artists of this school evince, in their treatment of this class of subject, a certain power that gives interest to their work. The vigor and solidity of their method, united with a skillful apprehension of the technical value of the *spot*, in landscape, are qualities which render their work effective, at least,—if, indeed, to be effective is not necessarily to be truly artistic. It is to be regretted that the exhibit of this nation, which was a large one, contained no examples of Lambinet, Ziem, C. F. Daubigny, Rousseau, Diaz, the Bonheurs, and others. And the deceased painters Troyon and Corot should likewise have been represented. Historical painting in France has given place, as elsewhere, to *genre*,—that is, if we accept the old conventional idea of history-painting, not infrequently based on mere extent of canvas and the hackneyed themes of classic verse. In a less conventional sense, however, the French school was perhaps never stronger than at present in history, if we accept the works of M. Gérôme and M. Meissonier as representative of this class of subject. It is now discovered that *genre* may be even more strictly historical in character than canvases of a more pretentious title.

While we recognize much that is of a superior order of excellence in French art, and accord this excellence perhaps the highest place and praise, as a school it is not exempt from many vicious tendencies that are not only subversive of good taste, but which tend directly to destroy a genuine and healthy feeling for art; and these tendencies were abundantly displayed at Philadelphia. In fact, owing to the absence of better work, this impression dominated all others, and in order that we shall not do injustice to the more genuine character of French art it is necessary to bear in mind that this representation was not complete. As an example of the style to which reference is here made, we may select M. Perrault's picture termed "Rest,"—an *odalisque* reclining in a hammock above a running stream, in a sylvan solitude. The thorough knowledge of the human figure here displayed, the admirable drawing, the firmness and roundness of skillfully-modeled forms, and the clearness of the tones and flesh-tints, render this work captivating to the eye; but in saying this we say all that may be said of it in praise. This admirable rendering of the external forms, this clever execution, this merely realistic display of flesh, stimulate no elevated emotion, enkindle no reverie. It is an attractive and artful appeal to mere sensuous emotion in the absence

of any higher aim on the part of the artist. And this is by no means an exceptional illustration of tendencies that are very pronounced in this school. It is perhaps a natural consequence of an excessive contemplation of the external, and a direct issue from allowing mere technical execution an undue prominence.

A very ambitious illustration of the sensational in art is that of "Rizpah defending the Bodies of her Sons," by M. Georges Becker. This is a product of the annual exhibitions of the *Salon*, where it has become necessary to startle, or strike the observer with force, in order to command attention. Exaggeration and strained effect is essential for this when greater powers are wanting, and the artist has here secured a sensation, not by means of the sublime or the impressive, but through the horrible, the ghastly, and the melodramatic; and his technical skill has been more than equal to his purpose, for the picture is not without decided merit of this kind: indeed, in this particular it is more than clever,—it is masterly. Another equally large canvas is that of M. Clement, "The Death of Cæsar." When one has in mind the admirable and dramatic treatment of this subject by M. Gérôme, and that cool reserve power with which this artist has dealt with the historic facts of this great event, with profound learning as well as with great artistic skill, M. Clement's attempt appears altogether inadequate. The instant is ill chosen, and the action unhistoric and forced. A subject of such moment, about which cluster historic interests of the gravest kind, foreshadowing results to which limits can hardly be assigned, should not be treated as if it were a mere brutal assault in the amphitheatre. There are silent, inwardly-acting reserve forces of which a great artist knows how to avail himself in selecting the true moment for such a picture; but in this case M. Clement has not risen to a level with his task.

While we notice these overstrained tendencies and false aims, it would be unjust to allow them to overshadow the acknowledged merits of this school. Since David gave to French art an impulse which impelled it forward in the direction of thoroughness of form, it has made steady and rapid progress. It has oscillated between classic and romantic influences, which have both contributed materially to nourish its growth. Ingres further stimulated that classic influence which is still strongly felt, while Géricault and Eugène Delacroix led the reaction of the romanticists, which is the influence now most pronounced. Had the exhibit of this nation at Philadelphia shown something of this march or progress in the development of French art, with but single examples of representative names, such as David, Ingres, Flandrin, Delaroche, Robert-Fleury, Delacroix, Couture, De-

camp, and the recently-deceased artists Hamon and Gleyre, and others, together with the works of the foremost living artists of this school, the result would have been eminently instructive as well as satisfactory, and the impression made would have been quite a different one. So many admirable examples have been brought to this country of late that it may be said, without exaggeration, that its leading artists are quite as widely and favorably known here as they are in France, and not infrequently through their representative works. This opportunity for study renders it very easy to discriminate between that which is truly excellent and that which is imitative and meretricious in French art; and it is well to have it clearly understood that this distinction is now generally recognized.

In sculpture, the works in the French exhibit that commanded attention were in bronze: notably M. Bartholdi's "Young Vine-Grower;" "The Bohemian at the Spring," by M. Ross; "The Juggler," by M. Blanchard; "Italian Shepherd," by M. Moreau-Vauthier; "Mercury, Whispering," by M. Moulin; and "Girl of Megara," by M. Barrias. These works reflect some of the merits that are widely recognized in French sculpture, which evinces a decidedly original and successful attempt to infuse into it the spirit and sentiment of modern life by drawing its inspirations not merely from tradition, or from a cold and calculating intellectual eclecticism, but from the living sources and sentiments that in every great epoch give character to art.

GERMANY.

Germany's exhibit, as a whole, in painting was one of but average merit, and we looked in vain for the works of some of her more distinguished artists. It was, however, so far characteristic as to enable us to form a just conception of the leading tendencies of this school.

German art is divided into two distinct schools,—those of North and of South Germany,—and there are few points of resemblance between them. The art of Northern Germany is inspired by the influence of the Düsseldorf school; that of South Germany by the school of Munich. The former is almost exclusively devoted to *genre;* the latter has been devoted to history-painting; and their styles are quite as distinct as those of two separate nations. The Munich school rose into prominence through Overbeck, Cornelius, Schnorr, and Kaulbach; while the Düsseldorf school achieved its high reputation through Schadow, Lessing, Bendemann, Camphausen, Hildebrandt, Richter, Hübner, Becker, Knaus, the Achenbachs,

and others, who have made recent German art favorably and widely known. The Munich school has of late in a measure forsaken its strict adherence to history, and as a school of art-discipline it is a formidable rival of the famous École des Beaux-Arts in Paris, in some respects perhaps surpassing the latter. With the character of Düsseldorf art we were made familiar in this country some twenty years since through the "Düsseldorf Gallery," in New York, which for some time formed a great attraction, and was a very adequate exponent of the merits of this school. German art is always pure in sentiment, generally, of late, domestic in character, and actuated by the influence of subject rather than treatment. In technical qualities it is usually monotonous in color and precise in execution, not imaginative in any suggestive or subtile way, but carefully wrought out in story. These may fairly be said to be its more prevalent characteristics; but there are not lacking superior qualities in the productions of German artists of the first rank that are unsurpassed in any school: this is particularly true of the works of Ludwig Knaus.

In historical painting the German school is often formal and conventional, intellectual rather than emotional, cold and dry in execution; but in domestic subjects the prevailing sentiment is always cheerful, healthful, and pure. In landscape, with the exception of a few distinguished painters,—the most notable being Andreas and Oswald Achenbach,—the rendition is decidedly formal and mannered. Portraiture in landscape is more generally the aim, and there is little attempt to draw from the inspirations of nature the simple elements of form and expression which in the French school have made this branch attain the highest level of art.

In the German exhibit the most attractive landscapes were "Storm at Vlissingen," by Andreas Achenbach; "Harvest in Holland," by J. von Starkenborg; "In the Park," by F. Hiddemann; and "Environs of Munich," by R. von Poschinger. Mr. Achenbach's picture was not one of his best, but it gave a good idea of the admirable quality of his art. "The Venetian Nobleman," by C. Becker, was likewise not adequately representative of this artist's best qualities. There are much finer examples of his work in some of our own private collections.

In portrait-painting the most notable works were G. Richter's portrait of the Hon. George Bancroft, the Crown Prince of Germany, by C. Steffeck, and "A Lady with a Rose," by G. Gräf. There were no pictures of superior and conspicuous excellence in this collection, so that it is difficult to select any for special mention. The collection, as a whole, was one of about equal or average merit, and while repre-

sentative of the general characteristics of German art it hardly did justice to individual artists of this school.

In sculpture the German exhibit was not important,—a bust, in marble, of Count von Moltke, by L. Brunnow, and a colossal bronze statue of Prince Bismarck, by H. Manger, being the most noteworthy.

AUSTRIA.

The exhibit of Austria in painting was a very creditable one, though the distinctive excellence of the collection was due to the conspicuous merit of a few works of unusual power,—notably, Hans Makart's immense canvas representing "Venice rendering Homage to Catherine Cornaro," which, in richness and splendor of color, in largeness of composition, and in facile freedom of execution, is well worthy of high praise. This picture attracted a great deal of attention at the Vienna International Exhibition, and has been greatly commended by the press. It is of a style of art that is essentially decorative, but in that large sense in which many works of the Venetian school are so classed. The motive, or theme, is one which seeks expression through the medium of color rather than in form or the other elements of pictorial art, and in this particular it is one of the most successful attempts of recent art. The drawing does not exhibit that knowledge of the human form which is a first requisite of the leading schools, but as a triumphant display of the charm and power of color united with a large style of composition it is in many respects masterly. It is also a successful manifestation of independence in art, guided by a true artistic instinct; and this is to be commended, when successful, as it is in this case, in view of that tendency to exalt accuracy of detail at the expense of expression. A portrait study, by Charles Probst, has exceptional merit. The expression and attitude are very natural, and the technical treatment skillful. It was one of the best portraits of the Exhibition. Two portraits by Henry von Angeli are characteristic, though not representative of this artist at his best. It would have added greatly to the interest of the Austrian exhibit had Von Angeli contributed something in *genre*,—as, for instance, such a work as "The Avenger of his Honor," which is widely known. "The Page," by J. Canon, is particularly pleasing; the coloring is rich and harmonious, reminding us somewhat of Rubens, and the execution is free and finished. "Bathsheba," by A. George Mayer, "Pan and Bacchantes," by Eugene Felix, "Girl of Upper Austria," by Ernest Lafite, "The Nun's Reverie," by G. A. Kuntz, are all works of merit, though not excellent if we apply to them a high standard of criticism.

In landscape, Austria did not exhibit works of decided merit; and

perhaps nothing in this branch of art was more pleasing than the pictures of Louisa von Parmentier.

In water-color painting the pictures of Ralph Alt are worthy of mention; and in etching the exhibits of W. Unger deserve high praise. They are admirable in some of the finest qualities of this art.

While it is not an uncommon thing to confound the art of Austria with that of Germany, a very decided distinction subsisted between the exhibits of the two nations. There was a marked evidence of a recent advance in the progress of Austrian art, which finds no better illustration than in the works first cited, particularly in that of Hans Makart.

BELGIUM.

Belgian is closely related to French art. It is well disciplined, vigorous, and generally unconventional. The Belgian exhibit was one of the best, and, though we missed some names that would have given completeness to this representation,—such as Gallait, Wappers, Baron Leys, Alfred Stevens, Willems, Lamorinière, and Alma Tadéma, who exhibited elsewhere,—nevertheless the collection, on the whole, showed favorably the characteristics of this school.

"The Confederates in the Presence of Marguerite of Parma," by Franz Vinck; "The Sculptor," by Victor Lagye; "Dante and the Young Girls of Florence," by N. de Keyser; "Saturday in the Monastery," by Franz Meerts; and "Griseldis," by Jules Wagner; are the most prominent works in *genre;* and in landscape, "After the Rain" and "Before the Thunder-Storm," by G. van Luppen; "Mill on the River Scheldt," by Jacques Rosseels; "Autumn," by F. Keelhoff; and "Using the Life-Boat," by Th. Weber, are the most favorable examples. "Deception," by Jean Portaels, though disagreeable in expression, exhibits great skill in technical treatment. "A Christian Martyr in the Reign of Diocletian," by Ernest Slingeneyer, was one of the most powerful and impressive pictures of the Exhibition. There is a solemn thoughtfulness in the conception of this admirable work which places it in the foremost rank of recent art. Too high praise cannot be awarded those manifestations of true art that rise superior to the ordinary level of external qualities which are apt to be over-esteemed at the present time. There is a silent power, a true dramatic interest that stimulates the moral sense, in this picture, which cannot well be too highly commended. While we find the sensibility pleasingly affected by technical surprises, it is rarely that our deeper feelings are stirred as they are by this solemn and effective picture by Ernest Slingeneyer.

Belgian art has had a decided influence on the art of Northern Germany, and geographical influences have in turn largely affected the style peculiar to this school. The influence of France on the one hand and that of Holland on the other are not infrequently perceptible in Belgic art, which nevertheless has distinct qualities of its own that render this school deservedly famous.

In sculpture, A. F. Bonré contributed several studies of animals, and P. Comerin some terra-cottas, that are worthy of mention.

THE NETHERLANDS.

The exhibit of the Netherlands was fairly representative of the admirable qualities of recent Dutch art. While there is evident adherence to the traditions of this school, there are not lacking strong suggestions of external influences that are rapidly demolishing old distinctions of this kind. With such a mighty ancestry of famous painters, it would be strange if Dutch art were not of a high order of excellence; and something of this influence may be found in the works of C. Bischop. Two portrait studies, entitled "At Church" and "Dieuwke," were unsurpassed by anything of the kind in the whole Exhibition. Admirable in expression, in force of chiaroscuro, and in richness of coloring, these pictures are worthy of highest praise. The tones are clear and deep, and the roundness and relief of the forms are rendered with great skill. "The Deacons of the Silversmiths' Guild conferring a Certificate," by J. A. Stroebel, while tending towards the conventional, is nevertheless admirable in many estimable qualities, broad and simple in treatment, and pure in tone. "The Card-Players," by J. Israels; "On the Beach," by J. Bosboom; "Gamblers, Seventeenth Century," by H. F. C. Ten Kate; "Norwegian Women," by H. A. Van Tright; "Hauling up the Fishing-Boat," by A. Mauve; "Haymaking in Normandy," by W. C. Nakken, and landscapes by J. W. Bilders and J. F. Van Deventer, are well worthy of special commendation; and "Still Life," by Miss M. Voss, was quite superior to anything of its class in the Exhibition.

On the whole, the exhibit of the Netherlands in painting was a favorable one. Wherever there is evidence of a proper adherence to the style and methods that have prevailed with so much credit in the past, Dutch art maintains a high place, and in some respects, as in the works of Bischop, has qualities that are unexcelled at the present time. Landscapes and cattle-pieces abounded, and in *genre* there were not wanting examples of conspicuous merit.

SPAIN.

A marked feature of the exhibit of Spain was the prominence accorded historical subjects. The Spanish school of to-day is not surpassed in technical excellence nor in the profounder aims of art; but, as many of their strongest painters have pursued their studies in Paris, where their works are to be seen rather than in their own country, these have been more popularly classed with the French school. Zamacoïs, Fortuny, Madrazo, Agrassot, Ruiperez, Vallés, Gisbert, Vera, Escosura, and others, have made Spanish art favorably and widely known. The first united with extraordinary technical skill a profound and subtile meaning in his art. He was perhaps the most accomplished and piercing satirist of the time.

The Spanish collection at Philadelphia contained several representative works of great interest. A very large picture of "The Translation of St. Francis of Assisi," by B. Mercadé, was well worthy of study. The subject is treated with great purity of feeling and, indeed, solemnity. The expression of the heads is very fine, and the composition simple and impressive. The picture is cold and monotonous in color, but in the sincerity of its aim it is admirable. "The Insanity of Donna Juana de Castilla," by L. Vallés, is also a work of great power; and "The Landing of the Puritans in America," by A. Gisbert, is serious and thoughtful; the figures have great dignity and simplicity of character. These pictures were loaned by the Museum of Fine Arts at Madrid.

"The Two Friends," by J. Agrassot; "The Burial of San Lorenzo, at Rome," by A. Vera; and "Sacristy in the Cathedral of Avila," by P. P. Gonzalvo, are also conspicuously worthy of commendation.

In landscape the Spanish exhibit contained little that evinced marked sympathy with this branch of art; and in sculpture the only examples worthy of mention were "The Wounded Bull-Fighter," by R. Nobas, and "Dante" (in bronze), by G. Suñol.

The impression gathered from the large historical works mentioned above was a very favorable one, and in this style of art the Spanish exhibit was especially admirable.

ITALY.

The Italian exhibit in painting did not do justice to the reputation which this school now enjoys through the widely-known merits of certain Roman artists, whose works we here looked for in vain.

Italian painting has recently acquired new life and vigor, partly through the influence of the French school, but mainly by a very

praiseworthy return to the serious study of nature, in lieu of the conventional adherence to formal traditions that had long been unfavorable to its progress. Within the past few years it has made an extraordinary advance and acquired thorough technical methods peculiar to itself, as well as great brilliancy of coloring. But the true excellence of this school was not represented at Philadelphia. The most noteworthy pictures in the collection were the "Evocation of Souls, from 'Robert le Diable,'" by R. Fontana; "The Interior of St. Mark's," by Luigi Bisi; "Interior of the Choir of the Cathedral of Parma," by S. Marchesi; "The Escort," by G. Fattori; "Preparation for a Feast at Pompeii," by A. Scifoni; "A Grandmother's Admonition," by M. Cammarano; and two portraits by C. Maccari,—the latter being specially commendable. It is to be regretted that a more adequate representation of the merits of this school was not given.

In sculpture the Italian exhibit was very large, abounding in what may be termed *genre* sculpture,—in subjects of a domestic and familiar character that are better suited for pictorial representation than for plastic art. The impression made by these works was not a favorable one. The display of remarkable subtlety in the manipulation of material, in the dexterous undercutting and intricate chiseling, which rendered many of the sculptures curiosities rather than works of art, gave evidence of great skill in workmanship; but there was little that was essentially and vitally sculpturesque, and the collection, on the whole, was frivolous and unimpressive. There were, however, some works that bore evidence of a more genuine artistic aim, and among these may be mentioned "Modesty" and "Hope," by A. Botinelli; "Love is Blind," by Donato Barcaglia; "Timidity," by L. Torelli; "Youth of Michael Angelo," by E. Zocchi; "The Flower," by C. Pietro; "The White Rose," and "The Orphan," by P. Guarnerio; "Dreams of Youth," by G. Argenti; "Boy and Swan," by R. Perduzzi; and "Love's Nest," by R. Perida.

The wood-carvings of Luigi Frullini were worthy of admiration, exhibiting great beauty of design and very subtile skill in execution.

SWEDEN.

The exhibit of Sweden in painting bore evidence of very decided merit. French and North German influences are plainly recognizable, and it is difficult to trace a distinctive national character in their art; but, on the whole, there is proof of sound discipline and true artistic aims. A most admirable portrait by Count von Rosen was not surpassed by anything of the kind in the Exhibition. It is painted with

rare skill and feeling, fine in color, and well drawn. An "Odalisque," by Hugo Salmson; "Maid with an Open Letter," by G. Saloman; and "Market Day in Düsseldorf," by A. Jornberg, were the most noteworthy *genre* pictures of the collection; and in landscape, "Birch Forest," by E. Bergh; "Fishing Harbor," by Baron Hermelin; "Beech Forest," by A. Kallenberg; "Coast Scenery," by A. Nordgren; "Moonlight Landscape," by H. A. Wahlberg; and "Summer Evening," by P. Ekstrom, are worthy of special mention.

In water-color painting the most favorable examples were by Miss Anna Gardell.

NORWAY.

The Norwegian exhibit in painting resembled that of Sweden in character. The best examples of the figure bore evidence of foreign training and influence, and, while they exhibited decided merit, there was little that was distinctively national. In landscape, however, this is less marked.

The most important picture of the collection was "Ruth and Boaz," by Otto Sinding. This picture is a production of mature art, admirable in sentiment, in breadth and freedom of execution, and fine in color. The figures are thoroughly well drawn, and the landscape skillfully rendered. "A Fresh Breeze," by H. Gudé; "Birch Forest," by S. Jacobson; and "A Summer Morning in the Birch Forest," by J. M. Grimelund, are also commendable.

RUSSIA.

There was very little in the Russian exhibit in painting of a character to warrant favorable criticism. The pictures displayed but little technical skill, and were generally dry and mannered. The most pleasing examples were "The Sunday Tea-Party," by Alexis Koorzoochin; "Ice-Drift on the Neva," by A. Bogoliooboff; and the landscapes of J. T. Aivazowsky.

THE UNITED STATES.

It has been frequently charged that American art derives its inspirations, as well as its style and technical discipline, from the schools of Europe. But it requires no very intimate knowledge of its real characteristics to discern that this assertion has no foundation in fact. The character of our art in general is decidedly varied, it is true, but it is quite possible to discriminate between that which is distinctively American and bears the unmistakable stamp of originality, and that which is either the work of artists of foreign birth residing in this country or of Americans residing abroad and adopting the manners

of foreign schools. The distinction is clear enough, and one that is easily recognized. In landscape-painting it is not an exaggerated estimate of American art to claim for it merits that are unsurpassed by the contemporary art of any people. In *genre*, also, there is evidence of original aims derived from the conditions of our life and character, though in a less marked degree than in landscape. Nor is it a matter of surprise that American art should have made such rapid progress in its development, when we consider the fact that our civilization is not the result of a slow and gradual advance from barbarism, but that its original elements were derived from peoples already matured in the civilizing arts under old and experienced systems of their own. The forming influences in our national life have not only had a high intellectual origin, but from the earliest dawn of our existence as an independent people this character has been sustained by our scholars, men of letters, and scientists, who have filled no subordinate place in the general intellectual progress of the past century. And, although laboring under the peculiar disadvantage of surroundings almost destitute of everything that tended to promote a knowledge of art in the earlier days of our history, our older artists were not less widely esteemed than our representative men of other professions, nor were their merits less conspicuous. Allston, Copley, West, Stuart, Trumbull, and Newton were no less favorably and widely known in Europe than in their own country; and it may be affirmed of them without extravagance that at that time—at the dawn of the present century—there were few artists of greater merit in any country, so recent a thing is the extraordinary and prolific development of art in all its branches which we witness to-day. And it cannot be said that this development, in all cases, is intrinsically what it appears on its face to be,—a march of progress. The technical resources of the arts have been enlarged and perfected, skill and method have been acquired through discipline, and the training that is requisite for successful competition in the arts is now necessarily severe and prolonged; yet it would be difficult to discern in the portrait-painting of the present time, in any country, a better style or higher order of excellence than is manifested in the portraits of Copley and Stuart. In short, the progress is one of technical externals rather than of genuine artistic aims—the expressive and thoughtful—which give value to art.

In historical painting, West, Allston, Trumbull, R. W. Weir, and Leutze have produced works well worthy of respect. In *genre*, also, there has been a natural and spontaneous expression of American life and character. Mount and Edmonds may be said to have origi-

nated with us this class of art, which has attained a conspicuous place of late. But in landscape the development of American art has been marked by originality and decided excellence. The strong tendency towards this class of painting may perhaps be accounted for by the fact that, until recently, the means for acquiring discipline in art have been of the most meagre kind, and the study of the human form was supplanted by the influence and beauty of our natural surroundings, particularly in its wild primeval grandeur. This partially filled the void occasioned by a lack of historic and artistic influences, and supplied an aim that has been fruitful of genuine results. Some years since, a few American landscapes found their way to the exhibitions of Antwerp and Brussels, and a distinguished Belgian artist declared "the works of American artists there exhibited to be among the most characteristic of the kind ever brought to that country." In this branch of art the United States suffered little by comparison with the best works of foreign schools, nor were its individuality and merit impaired by this juxtaposition. In *genre*, however, the comparison was decidedly unfavorable for us, especially when contrasted with the technical skill and thorough discipline manifested by the French and Spanish schools. Yet even in this class of painting originality of aim was conspicuous, as shown in the works of La Farge, Hunt, Vedder, Benson, E. Johnson, Homer, Perry, and others, —the last three selecting their subjects exclusively from American life and customs, and with marked individuality of treatment. The first occasion wherein American art was brought in contact or competition with foreign art was at the International Exposition of 1867. The collection was small, numbering but seventy-five pictures, but, for the most part, it was well selected. An intelligent critic of the Exposition of 1867 wrote, "The American collection, as a whole, attracts attention, and has been very highly praised by the first artists of France."

But the International Exhibition at Philadelphia was the first opportunity for an adequate display of American art on its own ground, and under what should have been considered favorable circumstances, had not this been partially frustrated by an indiscriminate admission of unworthy works. But, notwithstanding this defect, the exhibit, as a whole, was a creditable one.

A feature of marked interest was the exhibition of the works of our older portrait-painters who link the present with the past century, as Gilbert Stuart, Copley, Allston, Morse, Newton, Trumbull, Jarvis, Inman, Sully, and others. Of recent portrait-painting there were admirable examples by Elliott, Furness, Stone, Huntington, Baker,

Gray, Healy, Hunt, Page, Hicks, Staigg, Le Clear, Porter, and Miss A. M. Lea. Mr. Huntington's style is pleasing, correct in drawing, and always characterized by refinement of feeling. Mr. Baker is particularly agreeable in his treatment of female heads. Mr. Hicks's portrait of General Meade is manly and vigorous. Mr. Page seeks the more subtile modulations of form, and his portraits are suggestive, luminous, and skillfully executed, but with a peculiar method which renders them not always agreeable. His art, however, is always thoughtful and expressive. Mr. Porter's style is one of refinement and pleasing in color, in which qualities Miss Lea's portraits, also, are conspicuous for merit.

In *genre* the most noteworthy examples were by Boughton, E. Johnson, La Farge, Homer, Perry, Leutze, R. W. Weir, Vedder, Rosenthal, Chase, Shade, Shirlow, Loop, Benson, Bridgeman, Gray, Brown, Irving, Henry, Yewell, W. Thompson, W. H. Beard, Wood, C. C. Colman, and others; and in landscape-painting notably the works of Cole, Durand, Kensett, Gifford, McEntee, Church, Whittredge, Suydam, Hubbard, S. Colman, Swain Gifford, Cropsey, W. T. Richards, Bierstadt, Hetzel, De Haas, E. Moran, Bellows, D. Johnson, Miller, Bristol, Hill, Martin, Shattuck, James Hart, Van Elten, William Hart, Haseltine, Gay, Tilton, Fitch, etc. It is not to be inferred that the works of these artists are all equal in merit; but, on the whole, they represent American art in a general and diverse way. Their names have become familiar to the public, and their several merits have received more or less recognition.

Cole and Durand may properly be termed the fathers of American landscape. They first effectually inspired the artistic mind with sympathies whose influence is still felt. Cole was truly a poet in sentiment, and his simple landscapes possess a charm which time does not mar. Durand likewise stimulated into activity that latent feeling for this branch of art which has become a marked feature of the American school,—if the term is admissible,—and his rendering of landscape is extremely sensitive and refined.

The late Mr. Kensett was represented by two of his most pleasing works, "Conway Valley, New Hampshire," and "Lake George," the quiet and subdued sentiment of which is characteristic of his graceful manner. A serene and tender pastoral, and the more subtile modulations of tone in the landscape, had for him the greatest charm.

Mr. S. R. Gifford was represented by his "Sunrise on the Seashore," of which it may be said that the sea and its solitudes has seldom inspired a more profound motive, or one more adequately ren-

dered, than in this picture. "Tivoli" and "Lake Geneva" are no less admirable, but with a very distinct sentiment, and "Pallanza, Lago Maggiore," has a full, flooded sense of light, modified by tone, that is in every respect masterly in treatment. Two pictures by the same artist, "Fishing-Boats of the Adriatic" and "San Giorgio, Venice," are as strong and pronounced in color as the former works are delicate and suggestive. This artist is varied in his powers, and sustained, free, and finished in his methods. His pictures always manifest great elevation of thought and feeling. They are the interpretation of the profounder sentiments of nature rather than of her superficial aspects.

Mr. McEntee was represented by "October Afternoon," "November," "The Woods of Ashokan," "Frosty Morning," and "Late Autumn." These pictures are all characterized by great sincerity and decided poetic feeling. They evince a subdued yet intense enjoyment of those phases of nature that are tinctured with melancholy, and which are therefore none the less beautiful. This artist's style is expressive and sensitive, and, within the scope of his strongest sympathies, mature and confident. His pictures evince a profound insight that is intolerant of that Denner-like portraiture in landscape which aims at minuteness of imitation. They possess qualities of excellence that, in some respects, are unsurpassed in this branch of art.

Mr. Church contributed his "Chimborazo," which, while it is representative of his peculiar style, is not one of his best works: it is not equal to his "Niagara" or "Heart of the Andes." The eminent ability displayed by this artist in the works last mentioned merits high praise and has been widely acknowledged. Mr. Church views the landscape with the cool deliberation of the scientist rather than with the intensity of the artist: his estimate of its values and its facts, therefore, is rather scientific than artistic. His art is always attractive and brilliant, but has a tendency towards accumulation of detail in lieu of fullness of sentiment. His merits, however, are so generally recognized and have so properly won for him the distinction due to brilliant talents that his work rarely fails to attract attention and elicit praise. "Chimborazo" is one of a series of pictures the materials for which were sought in another continent; and the extraordinary enterprise manifested by this artist in visiting remote latitudes in search of subjects for his pencil was a feature of his art that has since found numerous imitators. But Mr. Church is not insensible to the fact that all the materials requisite for great art may be found always near at hand, and even among what is termed mere commonplace.

Mr. Whittredge contributed his "Rocky Mountains, from the Platte

River," "A Home by the Sea," "A Hundred Years Ago," "Twilight on the Shawangunk Mountains," and "The Old Hunting-Grounds,"—the latter an especially admirable example of his free, nervous style and of his felicitous treatment of wood-interiors. Mr. Whittredge's pictures of forest solitudes, with their delicate intricacies of foliage and the sifting down of feeble rays of light into depths of shade, are always executed with rare skill and feeling. His style is well suited to this class of subjects: it is loose, free, sketchy, void of all that is rigid and formal. It evinces a subtile sympathy with the suggestive and evanescent qualities of the landscape. But in his treatment of the open sky this artist is less happy: there is sometimes apparent a slight crudeness in his rendering of this feature of nature, that is open to unfavorable criticism. His pictures, however, always express a sincere and true motive.

Mr. Bierstadt contributed his "Yosemite Valley," "The Great Trees of California," "Mount Hood, Oregon," "Western Kansas," and "California Spring," no one of which equals his "Rocky Mountains," which some years since acquired a great and merited reputation and was a work of exceptional power. The earlier works of this artist showed a vigorous, manly style of art that had its undeniable attractions. His pictures exhibited at Philadelphia indicate a lapse into sensational and meretricious effects, and a loss of true artistic aim. They are vast illustrations of scenery, carelessly and crudely executed, and we fail to discover in them the merits which rendered his earlier works conspicuous.

Mr. S. Colman sent his "Merchant of Laghouats *en route* between Tell and the Desert, Algeria," which is characterized by the agreeable manner this artist has been pleased to adopt. There are some manners, or methods of treatment in art, that are so intrinsically pleasing that they appear to be exempt from the criticism that usually deprecates pronounced formalities of style; and Mr. Colman's manner is one of these. It is attractive, thorough in its technical method, pleasing in color, and in every other respect than that of composition—in which it is perhaps too formal—it is admirable and artistic. A little seeming negligence or unstudied effect in composition would produce a more agreeable result; and yet this very thoroughness of discipline in Mr. Colman's work offers a contrast to the not unusual weakness of our art in these particulars. Mr. Hubbard exhibited his "Early Autumn," "Coming Storm," and "Glimpse of the Adirondacks,"—the latter a characteristic example of his style, and luminous in its cloud-effects. Mr. Hubbard is particularly pleasing in his treatment of summer landscapes and afternoon skies, in

which class of subjects his art is attractive and often brilliant in its rendering of light and atmosphere, yet with a quiet and subdued tone. His style is not always equal, but it is expressive of true artistic sensibility and sincere motive. Mr. Bristol has lately acquired a more thorough manner, and his picture of "Lake Memphremagog" has decided merit. The evanescence of lights and shadows over the summer landscape is well expressed. Mr. W. T. Richards contributed but a single oil-painting, "The Wissahickon,"—not one of his best pictures. This artist is a careful, conscientious student of nature, but it is only recently that he has permitted himself to exercise that freedom and largeness of vision characteristic of mature art: his later works manifest this in a marked degree. No painter is more thoroughly master of the sea, and waves in motion, than is this artist. Mr. Thomas Hill exhibited his "Yosemite Valley," a large picture, and superior to anything of the kind in the Exhibition, in the way of attractive and realistic representation of scenery strikingly grand in its own elements. Such representations have held a prominent place in American landscape art. They appeal with force to the popular taste, and, while they are very distinct in their aim from the ends sought in more mature art, which is less dependent on novelty of materials, they are not without decided power when treated with the ability displayed by Mr. Hill or as formerly rendered by Mr. Bierstadt. Mr. Miller contributed his "Returning to the Fold," "The Road to the Mill," and "High Bridge, New York," all of which show decided merit with a strong foreign accentuation. Mr. De Haas exhibited "Moonrise and Sunset" and "A Brig hove-to for a Pilot," both marked by a strong German manner, brilliant in effect and vigorous in treatment, though somewhat formal. Mr. Hetzel exhibited a "Forest Scene in Pennsylvania," which was particularly pleasing and effective. Mr. James Hart was represented by a single picture, "A Summer Memory of Berkshire," which was an agreeable rendition of quiet pastoral landscape. Mr. Cropsey contributed "The Old Mill" and "Italy," two pictures very cleverly rendered, though with a peculiar manipulation characteristic of his style which is often pleasing. Mr. Swain Gifford exhibited "Boats at Boulah, on the Nile," and "An Egyptian Fountain," which show admirable vigor and breadth of treatment. Mr. Swain Gifford is best known through his Eastern pictures, in which his rendering of Oriental life and atmosphere is peculiarly happy. Mr. Gay exhibited "Windmills of Delfthaven, Holland," a very admirable picture, true in sentiment and skillfully executed.

In *genre*, Mr. Eastman Johnson contributed "The Prisoner of

State," "The Old Kentucky Home," "Sunday Morning," and "The Old Stage-Coach," which are all representative of the acknowledged excellence of his style. Mr. Johnson's subjects are derived fresh from nature, and are generally illustrative of characteristic traits of American life and customs. They are carefully studied, and always expressive of genuine feeling. They are not altogether free from uncertainty of form and touch and monotony of tone, but no one has more decided individuality and independence in choice and treatment of subject than this artist. His pictures bear the unmistakable stamp of originality. We are never reminded in them of the influence of schools or foreign methods: they rest upon their own merits, and the only comparisons they suggest are those afforded by the truths of nature. "The Old Kentucky Home" is the picture that first gave him his reputation, which every succeeding work has sustained and increased. "The Old Stage-Coach" displays greater maturity of method and breadth of treatment, but in accurate delineation of character "The Old Kentucky Home" is hardly surpassed. The impression made by Mr. Johnson's pictures is a genuine one. We instinctively feel that the artist himself was impressed and sought to express something that touched his sympathies forcibly. This is their interest and power, and criticism starts from this source, rather than from the mere pictorial elements of technical merit that usually, in artists of less character, first engage the attention. Mr. Homer was represented by two pictures, "Snap the Whip" and "The American Type,"—the latter a characteristic example of this artist's pronounced individuality. The expression of the figures is intense, full of meaning, and the tenacity of his grasp upon the essential points of character and natural fact is very decided. No recent work of this artist has equaled the remarkable excellence of his celebrated "Prisoners from the Front," an incident of the late war, which is a unique work in American art; but all his pictures have the merit of genuine motive and aim. They are often bald and crude in treatment and unskillful in technical method, while breadth is sometimes attained by the sacrifice of essential details which greater maturity of power would supply without loss to the former; for true breadth is not vacuity,—it contains the *sense* of fullness, if not the actual facts of detail. But that this artist evinces unique power and originality the slightest of his works amply testifies, and his aim is a sincere and true one. Mr. Perry exhibited three pictures,—"The Weaver," "Kept In," and "Young Franklin,"—all characteristic and distinctively American. This artist has made steady progress and adhered with commendable strictness to subjects within the scope of his powers and sympathies,

and he has gradually but surely attained a command over his materials that is worthy of high praise. His pictures are illustrative and pleasing, and evince a conscientious study of his subject. He has not yet attained complete mastery of the figure, nor are his pictures free from labored manipulation and thinness of method, but they evince very genuine qualities of merit.

Mr. La Farge sent five pictures,—two of figures and three of flowers. The latter are works of peculiar excellence for their purity and charm of color,—flowers forming but the theme for a most delicate and refined harmony that addresses the eye with occult power. Mr. La Farge is learned in his art, working for profound and subtile results, and no one is more sensitive to the value of mystery in tone and color and of the emission of luminous lights through these qualities. His picture of "St. Paul at Athens" is stamped with great sincerity of aim, and bears unmistakable evidence of power and thought. His works, however, for the most part, give an impression of incompleteness or suggest a deficiency of form, and the drawing, as of the hands in this picture of St. Paul, is often defective. But these shortcomings are more than compensated by the superior aim which characterizes his work and renders it highly intellectual, spiritual, and poetic in feeling. The two artists who, with us, have best illustrated the charm of resource that rests in harmonies of color are La Farge and Gray; and yet no two artists could be more utterly unlike in their methods and aims. Mr. La Farge shows more profound intellectual aim, tinctured with Orientalism, while Mr. Gray's work is influenced by simpler and more pervasive qualities of tone and the richness that is suggestive of a Venetian feeling. Mr. Gray is not always equal, and his pictures often remind one too strongly of the school that has influenced his style. But his "Apple of Discord" is, perhaps, in drawing, in purity of tone, and in the luminous quality of flesh-tints, unequaled in American art, and unsurpassed by any recent work of its kind in any country. Mr. Irving exhibited "The End of the Game" and "Cardinal Wolsey and his Friends," the latter a labored and skillfully-painted picture. Mr. Irving's style is imitative; but, while it lacks originality, it is not without decided merit, principally in technical qualities. His figures have often the appearance of actors dressed in the costumes of the stage and performing their parts cleverly, though not always naturally or unconsciously. But he has carried his art to that point of elaboration which is only surpassed by the most skillful artists working in the same field, by whom the French school is so largely represented. Mr. Brown contributed his "Curling Match," which is the picture that exhibits his

merits to the best advantage. Mr. Brown's subjects are derived from the homely incidents of every-day life, and are usually treated with simplicity and naturalness. His realistic powers are marked, but the sentiment of his pictures is not always equal to their technical qualities. Mr. Guy's subjects are of the same class. He contributed three pictures, "Evening," "Solitaire," and "Supplication," all domestic in character. His pictures are painted with skill, but over-elaborated and wanting in distinctions of texture. They are too studied, and consequently often lack spirit and life. Mr. W. H. Beard exhibited his "March of Silenus," a humorous picture, and one of his best, evincing remarkable powers of caricature. Mr. Henry exhibited "The Old Clock on the Stairs" and "A Morning Call in 1800," both very characteristic of this artist's cheerful humor and elaborate work. Mr. Henry's style is often ragged and unskillful, but his aim is a compensation, and he attains happily the sentiment of olden times. Mr. Shade exhibited a very charming picture called "Tantalizing," which evinced great technical skill, a fine sense of color, and a well-disciplined method of work. Mr. Shade is a pupil of the Munich school. Mr. Chase is likewise of the same school; and "Keying Up—The Court Jester" was a very clever example of his facility of method and rich coloring. Mr. Shirlaw, also a student of Munich, exhibited his "Toning of the Bell" and "Feeding the Poultry," two exceptionally strong and admirable works, evincing remarkably dexterous powers of manipulation. Mr. A. W. Thompson exhibited "On the Sands, East Hampton," and "Virginia in the Olden Time," both works showing marked evidence of discipline and careful study. There is a tendency towards the adoption of the French manner in this artist's work which shows whence he derived this discipline. It is a question whether a better manner may not be derived directly from nature without the interposition of another's method of viewing things. This is not only for Mr. Thompson to decide, but for Mr. Chase, Mr. Shirlaw, Mr. Shade, and Mr. Bridgeman as well. Mr. Bridgeman exhibited three pictures of remarkable power,—"Bringing in the Corn," "The Nubian Story-Teller," and "Flower of the Harem," all painted with great skill and truth. Mr. Vedder sent his "Greek Actor's Daughter," a thoughtful and poetic conception, painted with rare feeling and learning. Mr. Benson exhibited his "Strayed Masquers" and several Venetian studies which bore evidence of earnest study and a fine sense of color. Mr. Benson's pictures have of late been characterized by very decided ability. Mr. Rosenthal's picture of the "Young Monk" in the refectory of a convent was one of the most poetic in sentiment to be found in the whole exhibition. It is pure

and delicate in feeling, and skillfully painted. The "American Society of Painters in Water-Colors" occupied a gallery in the Annex, and the exhibit was an exceedingly creditable one. The paintings of most marked excellence were by Colman, Tiffany, Swain Gifford, Smillie, Boughton, Nicoll, Richards, Homer, Bellows, and Miss Bridges. Several of these artists were recommended for awards by the Judges in this group, but, on learning that the society competed as a body and did not allow of individual competition on the part of its members, their names were stricken from the list.

In sculpture the American exhibit was not satisfactory. Many of our most prominent sculptors failed to participate, and the character of the display was that of being composed of odds and ends, with here and there an occasional work of decided merit. Mr. W. W. Story exhibited his "Medea," and Mr. C. Calverly an admirable bronze bust of "John Brown." Mr. Randolph Rogers sent "Atala," "Nydia," and "Ruth," three statues of ordinary merit. Mr. D. C. French exhibited a very clever model in plaster, larger than life, called "The Minute-Man," and also a bust of Whittier. Mr. Connelly sent a bronze group, "Honor arresting the Triumph of Death," full of spirit and excellently well modeled. This sculptor also contributed his "Ophelia" and "Viola." Mr. T. R. Gould exhibited "The West Wind," and Mr. R. H. Park a number of pieces, among which were "Purity," "Summer," and "The First Sorrow." Mr. E. D. Palmer sent his excellent bronze statue of Robert Livingston, Mr. C. B. Ives his "Nursing the Infant Bacchus," and Miss Foley "Jeremiah" and "Cleopatra." Mr. John Rogers sent a complete exhibit of his statuette groups, which are well known for their clever, picturesque representation of incidents of the late war, and traits of American character and life.

The exhibit of sculpture, on the whole, lacked order and arrangement: the works were scattered, and were seldom to be seen to advantage. Nor was there any evidence of an attempt to illustrate the progress and present condition of this art in the United States, of which an interesting exhibit might well have been made.

CONCLUSION.

Reviewing the impressions gathered from the art-exhibits of the International Exhibition of 1876, we arrive at certain general conclusions respecting the character of the display.

An exhibition containing so vast a number of works of art (in painting alone the exhibit contained more than five hundred numbers

in excess of that of Paris in 1867), and collected from so many sources, must necessarily be far from select, and the first impression, which perhaps outweighs all others, is that derived from the large number of works of but average merit which, by force of numbers and extent, fill the eye of the observer. This is generally the case with regard to first impressions of art-exhibitions. The more glaring and conspicuous features—the crude, the violent, the bad, and the endless mediocrities that are neither good nor bad—carry the day. It is only by degrees and after the subsidence of these first impressions that works of real merit quietly and unassumingly assert themselves, and the garish, the meretricious, and the false sink to their proper level or remain thereafter unnoticed. It is then that a more deliberate and just impression is formed. If we were to accept the first impression as the true one we should perhaps pronounce the art-exhibit at Philadelphia a disappointing one. But first impressions are rarely based on critical estimates: the feelings, rather than the judgment, find exercise, and, for the most part, are affected by superficial considerations. When, therefore, we reflect upon the large number of really excellent works of art distributed through the galleries, and when we consider the fact that a majority of the most distinguished living artists contributed representative examples of their work, such sweeping estimates are out of place. In some instances, it is true, this representation was very incomplete, but in general it was a fair one and in many cases admirable and select. When we consider, also, how many elements are to be combined, and the large number of interests that are to be consulted, in forming an art-exhibit on so vast a scale, it could hardly be expected that it would have that unity and completeness which a single wise and vigorous direction might possibly effect.

It is a fashion in criticism to decry all art that has not the sanction of time or of established reputation to commend it, and it is a common platitude to apply standards of estimate that prevail in certain schools or in a bygone age as the only true and immutable estimates of merit. But art is by its very nature pliant and expressive, and as language undergoes continual change and modification with the necessities or conditions that mould and fashion it, so art is likewise subject to these conditions and the time of which it is a voice or expression. It is easy to discern the dominant tendencies of the art of the various nations gathered in this vast Exhibition, and these tendencies have been briefly commented upon in the preceding review. It only remains to determine the more general and prevalent characteristics of modern art as manifested in the art-exhibit as a whole.

The influence of large and oft-recurring Exhibitions is a question worthy of some attention. It is always noticeable that the exhibitions—as at the annual Paris *Salon*—engender products that are not always conducive to the promotion of a correct taste: the clever, the spectacular, and the meretricious often fill a conspicuous place and are held requisite to attract attention. The prominence thus accorded violence and exaggeration is doubtless injurious to the true interests of art, the genuine qualities of which, though lasting, profound, and sincere, are not well adapted to the conditions of such an arena. The artist, therefore, is tempted aside from his better aims to attain the rewards of popular success; and this is so far true that it is a very general custom for artists, particularly the younger members of the profession, to seclude themselves for a few months previous to the opening of the annual *Salon*, while at work upon their pictures for the exhibition. In other words, the picture is painted for the *Salon*, and the motive is that it shall command attention in this questionable competition. This leads to that prominence accorded technical cleverness, and often reduces the products of art to the level of objects of commerce competing in a common market. It would certainly promote the true interests of art if these exhibitions occurred less frequently, allowing time for more mature and thoughtful work. It is to those alone who are strong enough to resist and ignore this influence that we are indebted for the advancement of art in a true direction, and they compose the very exceptional and leading few whose work has permanent value.

The question of awards is also one that is subject to great diversities of view. Are the elements for comparison of sufficient exactness to allow of just and conclusive discrimination? In the case of mechanical industries and instruments of precision it is possible to set one merit over against another and compare definitely the results. But fine art is an intellectual product, a matter of truth of expression as well as of technical skill; and within any one branch of art questions of preference or comparative merit may arise that are incapable of this arbitrary method of solution. The elements for comparison being wanting, the judgment not infrequently rests upon individual tastes or caprice. It is idle to ignore questions of a higher kind and reduce this competition in art to mere matters of technical skill; and, on the other hand, the subject, though unskillfully rendered, may receive unwarranted preference. A balance of estimates, therefore, is impossible under the circumstances, and it is becoming very generally recognized that the conferring of awards in the fine arts is altogether unsatisfactory because not always properly discriminative. It has but little importance or

significance with those who really understand art, and it is not infrequently promotive of false and meretricious estimates. The true verdict in such matters is not always that accorded by juries of award, but that rendered by an intelligent and discriminating public.

The total number of awards conferred in painting and sculpture at the Exposition of 1867, at Paris, was one hundred and three, while at the Vienna International Exhibition of 1873 the total number awarded in these departments of art was seven hundred and eighty-seven. At Philadelphia the total number of awards in the same class was two hundred and sixty-five. At Paris the number of pictures exhibited was 2004; at Philadelphia the number was 2971. The following table will show the distribution of awards in painting and sculpture:

NUMBER OF AWARDS ADJUDGED.

Nations.	Painting.	Sculpture.	Total.
England	29	....	29
France	37	12	49
Germany	21	2	23
Austria	14	1	15
Belgium	16	4	20
Netherlands	27	....	27
Spain	10	2	12
Italy	12	16	28
Sweden	2	....	2
Norway	3	....	3
Russia	6	....	6
Canada	1	....	1
Brazil	1	....	1
Mexico	2	1	3
United States	41	5	46
Total	222	43	265

It has been the aim, in this report, to select those works that seemed specially worthy of comment, for the purpose of analyzing the character of the exhibits of the various nations, and in order to form some reasonable estimate of the tendencies that are most marked in the fine arts at the present time, as well as to form a proper critical review of the Art Department of the International Exhibition of 1876. This task has been, in some respects, a difficult one to execute; but the endeavor has been to render it free from personal bias, and if the estimates are not altogether accurate it is not from any lack of strict judicial purpose on the part of the author.

INDUSTRIAL AND ARCHITECTURAL DESIGNS; INTERIOR DECORATIONS; ARTISTIC HARDWARE; MOSAICS; INLAID-WORK IN WOOD AND METAL; STAINED GLASS.

BY DONALD G. MITCHELL.

The gentlemen with whom I was associated in consideration of the above-named classes of exhibits under Group XXVII. were M. Dahlerup, an architect of distinction in Çopenhagen, Mr. Peter Graham, a partner in the well-known house of Jackson, Graham, & Co., of London, and MM. Tantardini and De Sanctis,—the one a sculptor and the other a painter of established reputations in Italy.

At my suggestion, and agreeably to the sanction of the Commissioners, there were associated with the before-named Judges two Judges from other groups, in consideration of exhibits made under Class 441 and Class 453. In Class 441 our coadjutor was Mr. Richard M. Hunt, an American architect of established reputation, who had been specially assigned to the group of Architecture and Engineering. In Class 453 we were aided by the intelligent suggestions of Mr. R. H. Soden Smith, of London, who possessed quite special qualifications for the work in which he was called to our aid.

The awards throughout were made with great unanimity, and the particular reasons for such awards have been briefly expressed in the papers already submitted.

The general summary, which I have now the honor to present to you, is of course made upon my individual responsibility only; but, from a very full comparison of views with my associate Judges, I have no doubt that the opinions I have taken the liberty to express would meet with their general concurrence.

Under Class 440—Industrial Designs—but few exhibits were made. In addition to those to whom awards were adjudged I may cite excellent designs exhibited by Boucherat, Libert, & Troublé, of Paris; and I may also note, with perhaps undue nationality of feeling, some very clever designs which emanated from our educational establishments,—notably the Technological Institute of Boston,—but which by assignment of the Bureau of Awards were submitted to the Judges of the educational group.

Under Class 441—Architectural Designs, Studies, etc.—exhibits from the United States numbered two hundred or more, those from

Great Britain perhaps a score, and a still smaller number appeared in the Catalogues credited to France, Austria, or other European nationalities. Very decided picturesqueness of treatment characterized the better designs from United States exhibitors, as also in an eminent degree the British exhibit,—notably those of Mr. Burgess, of London. But in both cases there was absence of that fullness of detail and painstaking exhibit of constructive features which characterized the designs of French and Austrian architects.

An exceptional award was made to M. Viollet le Duc—whose work appeared only on the pages of his publisher, M. Morel—to mark and emphasize the appreciation which the Judges have of his skill, his taste, and that wide archæologic knowledge, which he has used to so excellent account.

Awards were also made to a Stockholm architect for careful reproduction of Gothic details, and to Sig. Catufi, of Rome, for judicious selection of simple and pure forms of classic ornamentation for educational purposes.

As the subject of architecture in all its phases, as presented at the Exhibition, is made the subject of a special report by a professional expert, I give no detailed mention of the exhibits under Class 441. I cannot forbear, however, to note three types of actual construction upon the grounds which were not without their good influences, in their several ways, upon public taste. I allude to the British homestead, the Japanese houses, and the Swedish school-building,—the first too quiet and homely for prevailing American notions, but showing by its picturesqueness and its elegant severities, both within and without, what a charm rigorous simplicity and homely quietude will always carry to a cultivated mind.

The Japanese buildings were notable for their nice joinery, and for the picturesque lines and solid construction of their roofs,—offering, in this latter respect, eminent contrast to the flimsy tile-roofs of the New Jersey State Building.

The Swedish school-house was in no sense what we should count a model school-house. Many American school-houses of similar dimensions are far beyond it in interior appliances and arrangement; but, on the other hand, there would be wisdom and a juster taste in replacing much of the flamboyant joinery and cumbrous cornices upon our country school-houses with the rugged severities and sturdy honesty of the Swedish structure.

Under Class 442—Decoration of Interiors—special exhibits were exceedingly few in number, scarcely reaching a dozen in all nationalities. The Judges, however, reckoned it within their official province

to consider various exhibits illustrating this phase of architectural work, though not embraced in the special classification. Among such I note first the wall-decoration made in connection with furniture-exhibits or of ornamental objects in metal and ceramics. To Messrs. Marcotte & Co. and Messrs. Pottier & Stymus awards were made for the artistic decoration of wall-surfaces in connection with their special exhibits under other classification. A like commendation was given to the wall-decoration connected with the furniture-exhibit of Messrs. Wright & Mansfield, of London, and to Mr. Cooper for the interior decoration of St. George's House.

It is quite true that all the products which went to make up the particular decoration referred to were not of the manufacture of the exhibitors,—as, for instance, the tapestry, the paper-hangings, etc. But the judicious selection and arrangement made to secure the artistic effects seemed to the Judges to warrant this departure from the general rule of the Department of Awards.

A medal was also adjudged to Doulton & Co. for the happy exhibit of such a variety of their terra-cotta and other artistic wares in connection with chimney-pieces, as suggests and admits of a beautiful style of interior decoration for homes. I may particularize specially an oaken chimney-piece, wholly simple in its character,—perhaps too carpenter-like in its severity,—but so set off with charmingly decorated tiles illustrative of familiar Shakspearian tale as to bring it within the most pertinent meaning of interior decoration. In the same general line, though the application is not so fully carried out, I may mention the very full tile-exhibit of Messrs. Maw and Minton,—to both which exhibitors medals were adjudged for the easy applicability of their wares to purposes of judicious house-decoration. I note also a medal to Messrs. Kaiser & Herzog, of Philadelphia, for their happy exhibit of actual wall-decoration and designs for the same. Messrs. Jeffrey & Co., of London, were adjudged a medal for a new and beautiful design (by Walter Crane) for paper-hangings. The design was exceedingly graceful and effective, and showed that culture and taste which, fortunately, are being brought more and more into service for the decoration of the interior of homes. A medal was adjudged to the very elegant chimney-piece placed on exhibit by M. Marchand, of Paris,—a superb piece of work; and though more suggestive of palace-decoration than of ordinary "interiors," its harmony of design and every-way artistic execution demanded full recognition and commendation. I also note the zinc and plaster copies of old arabesque ornamentation in the Egyptian collection, for their effectiveness and the perfect copies they present of many of the best old forms of Sara-

cenic decoration for interiors. It is gratifying to know that these will remain in the country.

Under Class 443 were grouped Artistic Hardware and Trimmings; Artistic Castings; Forged Metal-Work for Decoration, etc.

In the strict line of Artistic Hardware and Fittings there was a very small exhibit. England and France showed scarce anything, and the same was true of most European countries. There was indeed a large and varied show of American hardware, but not in general of such a character as to carry it within the cognizance of the Judges of Group XXVII., and in no single instance was it originally so classified or referred. It is indeed much to be regretted that, with the excellent opportunity which the manufacture of house "trimmings" gives for carrying artistic forms and treatment into every household, so little has been done in a thoroughly artistic way. Old forms, for the most part, have been preserved and ornamentation effected by covering with minute arabesque patterns, by coloring the metal by acid treatment or, in some instances, by crude and inartistic use of enamel. There is surely abundant room in the manufacture of door-fastenings, latches, hinges, window-trimmings, and the like, for a much fuller and more pronounced artistic spirit than has yet made itself felt.

By far the best show of hardware "trimmings" of a decorative character was made by Messrs. Corbin & Co., of New Britain, Connecticut, to which house a medal was adjudged under this classification. In their exhibit, butts and door-knobs of various styles were plated, executed in bronze or in clever bronze imitation, with close arabesque figures, and in some instances enameled. In this latter case the figures were too fine and borrowed too much from ordinary china decoration. Design should in this case be bold and pertinent to the position and the office. It is exceedingly difficult to *préciser* just what the best artistic direction of this class of work should be; but it is quite certain that very little as yet manufactured by the new labor-saving processes is satisfying to the artistic eye. The old system of forging the metallic trimmings for interior decoration and service gave much more latitude, it is true, and such work was, and is still, full of artistic suggestiveness. I note in this connection the admirable hardware show in the Spanish exhibit from the royal manufactories.* In all the articles comprising this exhibit there was

* I think I am right in giving the title of exhibitor, though from the fact that no Spanish Catalogue was supplied to the Judges, and no person in attendance seemed capable of giving definite information, it was exceedingly difficult to gain trustworthy knowledge in respect to the Spanish exhibit.

excellent workmanship,—no redundance of metal, no crude efforts at ornamentation, and most artistic forms. But these all, in forged trimmings, imply and demand an expenditure of time and labor which we cannot make sure of for objects of general service. We must make machinery do artistic labor with the metals as it does with cloths and broidery. Yet the Spanish exhibit was richly worthy of study, and it is to be regretted that it should not have been secured for incorporation with one of our industrial museums. Of course, the necessity of using the sand and mould in place of the forge would suggest modifications of the form. Much, however, may be done by the drop-forge and stamp, and certain good mediæval forms of hardware are already manufactured in this manner, of which some examples were on exhibition, but none of very special merit.

Castings of animal heads—dogs or lions—appeared in some exhibits in ornamentation of door-knobs, in certain examples quite effectively and spiritedly executed, but when well done involving a relief that interfered greatly with the convenience of the knob for easy handling. It is hardly a mode of decoration to be commended. No form, probably, can be suggested better than simple geometric ones with bold incised ornamentation.

Stair-rods, shown by Vandyke, of New York, were tastefully designed, and were effectively decorated in a very simple and unpretentious way. A medal was adjudged to these,—for though object and result were small and almost insignificant, we counted it of importance that artistic efforts of good tone and result in even the most insignificant objects adapted to house-decoration should have prompt recognition and commendation.

Within the limits of this special class I would also include and commend the very effective forged work and cast-work united, which has been adapted for chimney appurtenances and fireside-decoration, including fire-places themselves, fire-baskets of massive square forged bars, grates, fire-dogs, fenders, etc.

Very excellent examples in this line of work were shown by Messrs. Fertham, Cox, & Son, Barnard, Bishop, & Barnards, of London, and by Messrs. W. H. Jackson & Co., of New York. I take special pleasure in commending this form of decorative work, which carries the artistic treatment of the humblest metals into every-day domestic offices and keeps it before the eye month after month. Broader and larger educational effect is to be looked for thus than from the daintiest of palace gates.

Very beautiful and artistic forged iron-work for general purposes was shown by Messrs. Hart, Son, Peard, & Co., also by Messrs.

Mathews, and by Barnard, Bishop, & Barnards, which latter house showed also iron castings of wholly exceptional nicety and artistic design. They clearly surpassed everything in the way of artistic iron casting which came under our observation at the Exhibition.

An example of iron-forging shown by a Belgian artisan, M. Prosper Schryver, representing a vine with leaves, fruit, and tendrils, was a marvel of intricacy and delicacy, and although it could subserve no practical purpose, it showed a deftness of handiwork not unworthy of the days when such as Quentin Matsys wrought upon the forge.

Under the present classification I may also call attention to the well-studied designs shown by Baker, Arnold, & Co., of Philadelphia, for lamp-stands and gas-fixtures. They offered in their clever artistic treatment a pleasing contrast to very much that was shown in the same line of manufacture of very crude, pretentious, and inartistic design.

The ecclesiastic decorative-work exhibited by M. Poussielgue, of Paris, in plain and gilt bronze,—particularly the latter,—was very rich, exceedingly well executed, and, although displaying that excess of showy ornamentation which the Romish rites seem to demand, had the fullest commendation of the Judges.

In a similar line of church-work, I would commend that placed on exhibition by the Messrs. Lamb, of New York. It did not, indeed, approach the first named in extent, in variety, or in richness of decoration, but was worthy of special mention for its careful observance of excellent mediæval forms, its faithful execution, and the general good taste which characterized the exhibit.

For general excellence in artistic decorative bronzes, the well-known Paris houses of Susse Frères, Kaffel Frères, and Cornu & Co. were eminent. The exhibit of these houses, if showing no new design of surpassing excellence, yet gave evidence, in the careful rendering of favorite and familiar subjects, of their well-known skill. The adaptation of minor decorative pieces to various domestic uses was ingenious and piquant. Especially to be commended in this latter regard were the numerous and varied fanciful bronzes, for furniture-decoration, exhibited by M. Kaffel.

Yet it is a doubtful question if the race after novelties in tint, form, and treatment is not debauching the better art instincts of the Paris workmen. The bewildering and bizarre mingling of gilt and bronze, and silver and pearl and lapis lazuli, may express and typify the luxury and opulence of the day; but they do not so fitly express the best aspirations of art, or educate so widely, as the quiet monotone of a mellow bronze of Pradier.

Classes 450 and 451 embraced mosaic- and inlaid-work in stone, and mosaics in vitreous material, tesseræ, etc. As all mosaics, however, were inaptly allotted to Class 450, I remark upon exhibits under both classes without particular distinction.

In mosaics proper Italy was the only notable exhibitor, and as usual held her pre-eminence. It is to be regretted, however, that the Roman mosaicists should not have shown a wider range and more varied development. The old subjects were treated in the old way, and a review of the condition of their art in 1876 is only such as might have been made in similar terms fifty years ago. There seems no disposition to grasp subjects for illustration which might develop untried phases of the art.

The best—as might be foretold—were those offered (by favor of the Pope) from the Vatican *ateliers*, representing with rare faithfulness for so unyielding material the Seggiola Madonna, a Sassoferrato, and a Flower Piece. A head of Washington, by Gallandt (of Rome), attracted attention, as showing a welcome deviation from the stereotyped method of treatment, and a relief from the well-worn subjects of St. Peter's, the Campagna, and the Forum.

In the Florentine Pietra-Dura there was shown something more of latitude and a disposition to try new phases of development.

Orlandini (of Florence) exhibited, perhaps, the best examples of the old graceful arrangement of flowers and foliage, characterized by rare delicacy of execution and excellent taste in grouping. I name Niccola Scarselli, for his capitally-executed wild-fowl,—the rendering of the plumage being most cleverly done, and the whole work significant of a new departure in this old art.

Florentine mosaics representing human figures were ingeniously done; but full success in such a direction is impossible, and, it seems to me, not a line of development to be encouraged.

Some pavement in mosaic, of fair execution,—but not specially artistic in design,—were shown in both German and Spanish exhibits.

An example of altar ornamentation, shown by Minton & Co., in the tile mosaic, was noticeable, as also a bit of effective work in tesseræ, by Maw & Co.

To the exhibits of these two last-mentioned houses I have already given commendation. Nothing is to be said in addition, unless to call attention to the beautiful assemblage of tiles made by these houses, for wainscot, chimney-decoration, and for floors. An effort to reproduce wall-paintings of large reach, in tile, though fairly successful, seems a mistaken direction to take. No result of this sort, by such method, can be made capitally good. Within their own line

of work, however, the tile-makers have become decorators of the first importance.

Under Class 452 is grouped Inlaid-Work in Wood and Metal, Parquetry, etc.

In parquetry I note as having been worthy of special attention the excellent exhibit made by MM. Tasson et Washer, of Brussels. Its strong backing, judicious arrangement of parts, and generally artistic character placed it easily at the head of similar exhibits. Austria and Germany also made good show under this classification; and there was an American exhibit worthy of attention, under the title of wood-carpeting; the arrangement being clever and execution good; but it is at best an imitation of parquetry, and lacks the solidity which gives firmness and durability to the older forms of sound, inlaid-flooring.

Inlaid-work in wood, other than for floors or wainscot, was very properly catalogued for reference to the Judges of furniture.

Notice must, however, be taken of some rare and curious bits of inlaying for wainscot and other interior decoration shown in the Egyptian exhibit; it was commendable at once for its boldness, its great effectiveness, and its simplicity.

Some cabinet inlaid-work in wood, in the Japanese department, was conspicuous for the exceeding delicacy of its execution, and for its eminent solidity and firmness.

Inlaying of wood by pressure and dies, noticeable in the show of one of the exhibitors in the English department, not cognizable artistically, was referred to the Judges having such new phases of manufacture under consideration.

Inlaid-work in metal involves higher artistic precision, and immeasurably higher results, whether we regard design or execution. Before mentioning works in inlaid metal proper, I would call attention to a very remarkable exhibit in the Japanese collection, of wood inlaid with fine filaments of metal in such way as to show an artistic treatment of figures of animals, and arabesque ornamentation. The objects were not considerable or important in themselves, but as signaling a new development in Japanese art of singular delicacy, and evincing extraordinary nicety of detail, the Judges counted it worthy of special consideration.

The most conspicuous exhibit of inlaid metals, viewing the labor involved, the rare manipulation, and the variety of product, found place in the Japanese collection. Taking into consideration the material, the intricacy of design, the varied processes involved, and the artistic results, it is quite certain that Japan bore away the palm

from all Western nations. No description can give an adequate idea of the strange conceits, the mellow hues of the metal, the artistic contrast of tints, the bold, sculptured *plaques* of silver, emerging from golden-toned bronzes; the endless variety of shapes in vase, in cup, in flagon, in dish, in box; all showing wonderful inlaying with silver, with copper, with gold; and, in repeated instances, deep incised sculpture into the bronze vases, of marvelous fineness and precision of line. I make special mention of the work designed by M. Notomi, as showing the latest phases of Japanese art as qualified and refined by the classic traditions of the West.

The inlaid-work of the Messrs. Elkington, of Birmingham, is now of world repute. This house not only showed its trophies of the Vienna Exhibition, but other objects of art, which if of less importance in magnitude, were quite as artistic in conception, and showed an added delicacy of touch and more elaborate and finer execution.

M. Zuloaga, of Spain, made an exhibit, in every way wonderful, of that rich, embossed, inlaid-work which has given him fame in all the capitals of Europe. If less classic, and showing less delicacy of design than Elkington, he surpasses the British house in a Saracenic richness of detail, and in a profusion of golden embossments, in which his work is quite unrivaled.

The American house of Tiffany & Co. has entered upon the field of inlaid-work in metal, and made exhibit of vases, shield, pitcher, etc., of silver inlaid with copper and niello, in broad, conspicuous figures. The workmanship was thorough, and the contrast of tint—an unusual one to such ware—exceedingly effective.

The Japanese have made charming use of copper contrasted with a mellow-toned bronze,—conspicuously in one or two large vases at the Exhibition, where the copper appears in broad rays upon the pedestal; but its display upon silverware is quite novel.

The inlaid-work of Tiffany & Co. does not indeed commend itself to the popular mind like the elegant *repoussé* ware of the same house; but to intelligent and refined tastes it makes strong appeal for its simplicity, its severe ornamentation of enduring character, its happy contrast of tints, and its easy applicability to wares of every-day use, subject to all manner of strain, and to the handling alike of maid, mistress, and child.

Class 453 was devoted to Stained Glass.

The number of exhibits under this classification was not large. Great Britain was represented by a dozen or more. The United States showed perhaps as many in number of much less magnitude. France was conspicuous in the glass shown by M. Lorin, of Chartres,

—a work of first-class importance, for which it was found necessary to erect a special structure. The narrow space at command, however, worked great injury to the general effect, and no proper view could be had. The work was one of great excellence in the French school of glass-staining; its drawing eminently good; the leadings carefully placed; the colors brilliant; the subject very ambitious; not, perhaps, in best taste,—judged by other than French rulings; the shadows, too, somewhat overcharged; but with all minor drawbacks, a work of great distinction, and meriting the commendation it received.

A German work by M. Fettler, of Munich, was the only one approaching it in magnitude, and had the great advantage of good position and light. Its coloring was exceedingly brilliant throughout; the arabesque subsidiary features being specially noticeable.

England was worthily represented by Hardman & Co., of Birmingham; also by Haynes & Butler, and by Gibbs, of London.

The choice of familiar home subjects, charmingly treated, was observable in much of the English work, and commendable as an incentive to domestic use of this art. I specially note certain exhibits which appeared in the south gallery of the Main Building, full of translucence, engaging in subject, and giving charming effect, without any considerable sacrifice of light, admirably adapted to halls in private houses. This style of glazing is full of suggestion to those living in cities whose rear windows look upon neglected or dingy areas or courts, where the equipment of a window with rich design would be a perpetual delight.

The American exhibits were of fair execution, and several were commended to the Commissioners for their award.

In the range of miscellaneous objects of art, embraced in Class 454, there was little exhibited of special significance, or warranting any detailed mention.

REPORTS ON AWARDS.

GROUP XXVII.

1. Louis Bonnet, New York, N. Y., U. S.

CAMEOS.

Report.—Commended for cameos artistically cut.

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2. F. C. Vandyke, New York, N. Y., U. S.

STAIR RODS.

Report.—Commended for very tasteful enrichment, by bronzing, gilding, and embossment, of a very ordinary article of household use; this artistic treatment of a very homely object being, in our view, specially worthy of commendation.

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3. Miss A. De Etta Bloodgood, New York, N. Y., U. S.

STUDIES FROM NATURE IN WAX AND DESIGNS.

Report.—The material carefully prepared, the work exceptionally executed, with great taste and most faithful regard to the botanical features of the plants represented.

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4. William Hopson, Everett, Mass., U. S.

GRAINED WOOD.

Report.—Commended for skillful and effective graining and imitations of various woods and stones.

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5. A. Kimbel & J. Cabus, New York, N. Y., U. S.

CHIMNEY-PIECE IN WOOD.

Report.—Commended for symmetry and grace of design and admirable workmanship.

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6. L. Marcotte & Co., New York, N. Y., U. S.

CABINET IN BLACK WOOD CARVING.

Report.—Commended for an original design, style Henri II., beautiful proportions, and excellent workmanship; details rendered with great care and delicacy; a work of high artistic merit.

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7. Baker, Arnold, & Co., Philadelphia, Pa., U. S.

ARTISTIC CASTINGS—LAMPS AND KEROSENE BURNERS.

Report.—Good in execution, artistic in form. Commendable for the opportunity thus afforded to secure good artistic decoration in a household article of every-day use.

8. J. & R. Lamb, New York, N. Y., U. S.

ECCLESIASTICAL METAL WORK.

Report.—Commended for excellent taste, good workmanship, with careful and faithful study of medieval forms of decoration.

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9. Tiffany & Co., New York, N. Y., U. S.

SILVER INLAID WITH NIELLO AND COPPER.

Report.—Commended for beauty and simplicity of form, and for novelty of treatment, this method of inlaying with these metals not being heretofore practiced. The product is further commended for its very effective and pleasing contrast of colors, and for its admirable adaptation to practical uses and every-day wear.

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10. Miller & Krips, Philadelphia, Pa., U. S.

MEDALLION IN RELIEF—BRONZE.

Report.—Admirably modeled; good workmanship, and excellent material.

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11. J. L. Mott & Co. Iron Works, New York, N. Y., U. S.

CASTINGS IN IRON.

Report.—The designs are well chosen, mostly from classic models; the execution is clean and sharp; and we believe the products of Messrs. Mott will do good service in familiarizing the public with some of the best forms of classic art by their reduplication in so inexpensive and enduring a material.

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12. P. & F. Corbin, New Britain, Conn., U. S.

ORNAMENTAL HARDWARE.

Report.—Hinges, knobs, and other door furniture in this exhibit are treated with a large degree of artistic skill, and seem to us fairly to merit an award under the class designated Artistic Hardware.

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13. Henry Mitchell, Boston, Mass., U. S.

ENGRAVED SEALS AND DIES.

Report.—Commended for artistic execution of seals and dies.

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14. A. Marshall, Boston, Mass., U. S.

VITRIFIED ENAMELS.

Report.—Commended for vitrified enamels.

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15. Maw & Co., London, England.

MOSAICS IN TILES.

Report.—Commended for the admirable adaptation of the groupings of tile exhibited to purposes of interior decoration, in shape of wainscot, paneling, chimney ornamentations, and for hearths and flooring.

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16. Minton, Hollins, & Co., London, England.

MOSAIC WORK IN TILES.

Report.—Commended for artistic management of colors, effective grouping in decorative panels, more especially of those which are designed and arranged for chimney and hearth ornamentation.

17. Royal School of Art, London, England.

DECORATIVE NEEDLE-WORK.

Report.—Commended for artistic designs and excellent execution of various styles of needle-work adapted for hangings of furniture, the introduction of which into more general use would give employment to a better class of workers and vary the decoration of interiors.

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18. E. J. Poynter, London, England.

CARTOONS FROM MOSAICS.

Report.—Very fine cartoons; good style and very decorative.

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19. G. A. Audsley & J. L. Bowes, London, England.

ILLUSTRATIONS OF CERAMIC ART IN JAPAN.

Report.—Commended for excellent and artistic specimens of illustrations of the ceramic art of Japan.

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20. Elkington & Co., Birmingham and London, England.

INLAID WORK IN METAL.

Report.—Commended for great beauty of design and perfect execution.

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21. Cox & Sons, London, England.

FORGED METAL WORK; STAINED GLASS AND DECORATIVE PANELS.

Report.—The Judges have grouped the above products together as showing great artistic excellence and for their happy adaptation to purposes of interior decoration.

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22. Ortner & Houle, London, England.

SEALS AND DIES.

Report.—Commended as finely cut and artistic in design.

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23. Elkington & Co., Birmingham and London, England.

BAS-RELIEFS IN METAL, ELECTROTYPE AND REPOUSSÉ WORK.

Report.—Commended for their remarkable exhibit of bas-reliefs, electrotype copies, and original specimens; also for superior excellence of repoussé work in silver and iron, showing a very high standard of artistic merit.

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24. M. Feetham & Co., London, England.

ARTISTIC CASTINGS AND FORGED METAL FOR CHIMNEY DECORATION.

Report.—Commended for excellence and variety of designs for chimney appurtenances, being artistic in character and contributing largely by their use to effective decoration of interiors.

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25. Jeffrey & Co. (Mr. Crane, Designer), London, England.

DESIGN FOR WALL PAPER.

Report.—Commended for great excellence and chastity of design, connected with exceedingly harmonious coloring. Altogether, a most artistic exhibit of the large decorative effect which is possible with this material in the hands of a clever designer.

26. Hart, Son, Peard, & Co., London, England.

FORGED METAL WORK.

Report.—Commended for artistic design and admirable execution characterizing the varied objects submitted by the exhibitor. If we were to particularize, it would be by naming the great forged candelabra in the centre of main aisle, and various gates within the immediate compartment of the exhibitors.

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27. Barnard, Bishop, & Barnards, London, England.

ARTISTIC CASTINGS AND FORGED WORK IN IRON.

Report.—Commended for remarkably sharp and clean castings, showing well-defined, delicate lines, and great variety of artistic designs; also well-executed forgings in various forms.

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28. George Hetzel, Pittsburg, Pa., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Forest Scene in Pennsylvania."

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29. Charles Somers, of the University of Melbourne, Australia.

MEDALS IN WAX: MODELS.

Report.—These medals are of good design and well executed.

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30. Watson & Co., Bombay, India.

HAMMERED WORK IN SILVER, AND WOOD CARVING.

Report.—Commended for good taste and workmanship.

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31. A. N. Greig, Montreal, Canada.

IMITATIONS OF WOOD AND MARBLE.

Report.—Commended for the merit of his grained imitations of woods and marbles, some of which are formed into panels by margins ornamented with decorative designs in colors, producing a pleasing effect.

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32. Felix Chopin, St. Petersburg, Russia.

PORCELAIN AND BRONZE CANDELABRA.

Report.—Commended as admirably designed and well executed.

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33. First Japanese Manufacturing and Trading Co., Tokio, Japan.

INLAID BASINS.

Report.—Commended for exceeding beauty of the work; the designs most delicate and admirably wrought, in imitation of old Chinese work.

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34. Marunaka Magohei Exhibitor, Yamagawa Manufacturer, Notomi Designer, Kaga, Japan.

VASES OF INLAID WORK IN METAL.

Report.—Commended for great elegance of form; the vases inlaid with silver, gold, and copper (the latter metal of recent use for this purpose); admirable contrast afforded of

these metals with the dark olive-brown of the bronze base; relief effects produced by laborious and artistic chiseling; the whole worthy of special study by those engaged in artistic treatment of metals.

35. **Yamamoto Tasubeye, Suruga, Japan.**

INLAID WOOD: CABINET WORK.

Report.—Commended for the great beauty of natural woods, skillfully combined in great variety and forms, securing admirable effect. The richness of metallic trimmings is also specially noticeable.

36. **Namikawa Yasu-uki, Kiyoto, Japan.**

INLAID VASES AND BOXES.

Report.—Boxes and various products in inlaid metal; all treated with great grace and skill.

37. **Yomo Yasunosuke, Kiyoto, Japan.**

INLAID WORK IN METAL.

Report.—Commended for imitations of old china, inlaid with silver, of best execution, and charming in effect.

38. **Kanaya Gorosaburo, Kiyoto, Japan.**

INLAID GOBLETS AND BOXES.

Report.—Quaint but artistic designs of mellow-tinted bronze, inlaid with decorative figures in silver in high relief; workmanship excellent.

39. **Fukihara Shoroku, Tokio, Japan.**

ENAMELED PLATES AND JAR INLAID.

Report.—Commended for beautiful execution and characteristic Japanese designs.

40. **Louis Léon Marchand, Paris, France.**

MARBLE CHIMNEY-PIECE.

Report.—Commended for richness and largeness of effect; incised ornamentation and bronze enrichments contributing to fine artistic result. The Judges also name as worthy of award the beautiful decorative metal work upon the large ottoman from same exhibitor, with flower stand and candelabra rising from centre.

41. **Christofle & Cie., Paris, France.**

STATUETTES IN SILVER.

Report.—Commended for excellence in design and artistic execution.

42. **Meurice Froment, Paris, France.**

STATUETTES OF ANIMALS IN SILVER.

Report.—Commended for excellence in design and artistic execution.

43. Poussielgue Rusand, Paris, France.

ARTISTIC BRONZE WORK FOR ECCLESIASTIC PURPOSES.

Report.—Commended for superior execution of altar furniture in bronze gilt, enriched with enamel and imitation of precious stones; also specifying candelabras, cups, vases, and other objects for use in church service, all wrought with great brilliancy of effect.

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44. Aimé Joachin Léon Le Cointe, Paris, France.

BRONZE DECORATIVE VASE.

Report.—The Vase of Peace. Fine in style, and of excellent workmanship.

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45. Kaffel Brothers, Paris, France.

DECORATIVE BRONZE WORK.

Report.—Commended for the delicate taste and skill which characterize the varied forms of étagères, screens, flower stands, and small cabinets shown by this exhibitor, and the happy combinations of bronze gilt work with onyx, marble, enamels, and richly-decorated porcelains.

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46. Eugène Cornu & Cie., Paris, France.

DECORATIVE BRONZES.

Report.—Commended for the ingenious and most artistic treatment of the bronze gilt supports of onyx and marble tables, tazzas, and flower stands.

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47. Florent Antoine Heller, Paris, France.

ENGRAVED MEDALS, REPOUSSÉ IN SILVER.

Report.—Commended for excellence in workmanship and design in the production of medals made of wax and metal.

Electro-plate commended for excellent workmanship and good design.

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48. Susse Brothers, Paris, France.

BRONZES FOR INTERIOR DECORATION.

Report.—Superior execution and excellent taste in design, particularizing specially table and toilet mirror executed in bronze gilt, stands for lamps in bronze gilt, and in bronze oxidized in silver.

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49. Eugène Blot, Boulogne-sur-Mer, France.

SMALL STATUETTES IN TERRA COTTA.

Report.—Commended for excellence in modeling small figures.

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50. National Manufactory of Sèvres, Sèvres, France.

PORCELAIN.

Report.—Artistic taste in the design, and distinguished by the great qualities which this manufacture has always possessed.

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51. Paul Soyer, Paris, France.

ARTISTIC ENAMELS.

Report.—Of superior artistic excellence; of superior workmanship.

52. C. E. Lami de Nozan, Paris, France.

ENAMELS (FRANÇOIS I. AND HENRI II.).

Report.—Commended for charming taste and invention; distinguished by an appearance rich and vigorous.

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53. J. Mansuy Dotin, Paris, France.

ARTISTIC ENAMELS.

Report.—Remarkable for their vigor of tone and invention; worthy of great encouragement.

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54. Miss Elise Moussion, Paris, France.

ENAMELS.

Report.—Commended as beautiful in color and delicate in form.

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55. A. Pottier, Paris, France.

ARTISTIC ENAMELS.

Report.—Charming in design, color of finest taste in all respects, and of exquisite workmanship.

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56. Adrien Jean Houtmans, Brussels, Belgium.

DESIGN FOR LACES.

Report.—Commended for admirable delicacy and beauty of design. In both these respects, however, the cartoon submitted is surpassed by designs upon laces already executed and exhibited, which are understood to be the work of the same artist.

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57. Polydore Comein, Brussels, Belgium.

FIGURE IN TERRA COTTA.

Report.—"La petite Mère:" well composed, and executed in excellent style.

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58. Jean Jacques Labaer, Antwerp, Belgium.

REPOUSSÉ IN COPPER.

Report.—Commended as artistic; the design good; workmanship excellent.

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59. Placido Zuloaga, Madrid, Spain.

INLAID WORK AND REPOUSSÉ IN METAL.

Report.—Artistic designs, and most elaborate and admirable execution, in various forms of repoussé, all showing perfect mastership of this wonderful art.

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60. Alfred Wahlberg, Sweden.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Moonlight Landscape."

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61. The Spanish Government.

DECORATIVE HARDWARE—FURNITURE OF DOORS.

Report.—In recognition of the courtesy of the King of Spain in causing to be forwarded to this Exhibition so rare a show of carefully forged and artistically designed appurtenances

for doors, windows, etc. They are richly deserving of study by our manufacturers and industrial designers.

62. Egyptian Government.

COPIES OF OLD ARABESQUE ORNAMENTATIONS IN ZINC AND PLASTER.

Report.—Faithful representation of old and rich Oriental forms of interior decorations, which will have capital influence in properly directing decorative treatment after Eastern methods.

63. Joseph Parvis, Cairo, Egypt.

INLAID PANELING (DECORATIVE).

Report.—Commended as exceedingly rich and effective, though simple in its execution; wholly Oriental in character; worthy of special study.

64. J. Francisco Supplicy, Paraná, Brazil.

BRONZE MEDALS.

Report.—Medals of artistic designs; well executed.

65. Chev. Giuseppe Capannini, Rome, Italy.

CAMEOS.

Report.—Commended for superior design and workmanship.

66. Francati & Santamaria, Rome, Italy.

CAMEOS.

Report.—Commended for artistic excellence, good workmanship, admirable design.

67. L. A. Gallaudet, Rome, Italy.

MOSAICS.

Report.—Excellent and artistic execution of designs. With the exception of the Vatican work, we count the exhibit of M. Gallaudet foremost among the products of Roman mosaic art submitted to our notice. At the same time, we have to express a regret that this art should not find wider scope for its illustrations than in repeating over and over subjects familiarized by the practice of centuries past.

68. Nicola Scarselli, Florence, Italy.

FLORENTINE MOSAICS.

Report.—Commended for most artistic execution and happy and novel design, representing with great cleverness the plumage of wild fowl. Quite remarkable for its *vraisemblance.*

69. C. Roccheggiani, Rome, Italy.

ROMAN MOSAICS.

Report.—Commended for the very careful and artistic execution of landscape subjects familiarized by the Roman workers in mosaics.

70. Leopoldo Orlandini, Florence, Italy.

FLORENTINE MOSAICS.

Report.—Commended for great grace and delicacy of design, with admirable finish.

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71. Giovanni Scappini, Florence, Italy.

FLORENTINE MOSAICS.

Report.—Commended for quaint and novel designs executed with great nicety and artistic feeling.

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72. His Holiness Pius IX., Rome, Italy.

ROMAN MOSAICS.

Report.—The Judges respectfully ask from the Commission an acknowledgment of the Papal courtesy in submitting so rare and beautiful specimens of the art of Roman mosaic. The subjects are well chosen, and the finish exquisite,—the whole work showing artistic eye and aptitude most honorable to the skilled artisans who have wrought such delicate results with so unyielding material.

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73. Sig. Luigi Catufi, Rome, Italy.

REPRODUCTIONS OF OLD FORMS OF CLASSIC ORNAMENTATION FOR PURPOSES OF INSTRUCTION.

Report.—Commended for the care and truthfulness with which the spirit of the old classic ornamentation has been caught, and the exceptionally good effect which such pains-taking work in this direction must insure.

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74. Chev. Giuseppe Pellas, Florence, Italy.

REPRODUCTION IN GALVANOPLASTIC.

Report.—Commended for good workmanship from good examples of the best works of art.

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75. Société Céramique Farina, Faenza, Italy.

ARTISTIC CERAMICS.

Report.—The faïence manufactory of Farina is commended for the good taste, style, and variety of the objects exhibited devoted to decorative art. This manufactory is also worthy of praise for its moderate prices.

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76. De Poli Brothers, Venice, Italy.

BELL IN SILVER BRONZE.

Report.—Commended for artistic design, delicate and beautiful execution, musically exquisite tone.

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77. Alessandro Castellani, Rome, Italy.

OBJECTS OF ANTIQUE ART.

Report.—Signor Alessandro Castellani exhibits a collection of Italian, Greco-Etruscan, Roman, and Italian Renaissance faïence.

This collection is very remarkable, and, without doubt, should produce a strong impression upon all those who are concerned in the education of a people in archeology and art history. Especially is this true of America, where art and industry are in full development; and we should profit by these marvelous examples of antiquity to press forward in artistic taste.

78. Torquato Castellani, Rome, Italy.

PAINTING ON MAJOLICA.

Report.—Commended in that it presents very interesting specimens of different styles of the ceramic art in Italy since the year 1460 until the sixteenth century. The reproductions are executed with decorative design and harmonious color which is so difficult to obtain.

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79. Idar Oberstein Joint Exhibition, Germany.

COLLECTION OF CAMEOS.

Report.—Commended for a good collection of cameos admirably arranged.

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80. Prussian Porcelain Manufactory, Berlin, Germany.

DECORATIVE PORCELAIN.

Report.—Commended for excellent workmanship and artistic taste.

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81. Ludwig Brunnow, Berlin, Germany.

BUSTS IN MARBLE.

Report.—Commended for artistic excellence in busts.

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82. Bavarian Museum of Arts, Nuremberg, Bavaria, Germany.

GALVANOPLASTIC ELECTROTYPE.

Report.—Commended for masterly workmanship in the reproduction of works of art.

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83. Josef Zasche, Vienna, Austria.

PORCELAINS AND ENAMELS.

Report.—Commended as work of the highest order, distinguished by beautiful execution as much in its design as in its modeling.

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84. Anton Scharff, Vienna, Austria.

ENGRAVED MEDALS.

Report.—Commended for superior excellence in design and workmanship.

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85. Ludwig Böhm, Vienna, Austria.

BRONZE WARE.

Report.—Commended for good taste and excellence of workmanship.

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86. Peter Petersen, Christiania, Norway.

REPRODUCTIONS IN GALVANOPLASTIC.

Report.—Commended for good workmanship.

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87. Gottfried Berg, Stockholm, Sweden.

PORPHYRY TABLE OF INLAID STONE.

Report.—Commended for the artistic execution and rare finish of the slab forming the top of the table.

88. John McArthur, Jr., Philadelphia, Pa., U. S.

DESIGN FOR PUBLIC BUILDINGS IN PHILADELPHIA.

Report.—A grandiose plan, skillfully managed. The angles of roof hardly seem to us in complete harmony with lines of central dome; but it is a colossal work intrepidly treated and richly deserving of recognition and award.

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89. Schwarzmann & Kafka, Philadelphia, Pa., U. S.

VARIOUS STRUCTURES ON EXHIBITION GROUNDS.

Report.—The Judges particularly commend Horticultural Hall, and the judicious adaptation of minor offices to their respective purposes. The extemporaneous construction of Annex for paintings, so good in its lines and so well adapted to its object, appears to us to show clever facility for meeting and dealing with emergencies.

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90. R. M. Upjohn, New York, N. Y., U. S.

DESIGN FOR STATE HOUSE.

Report.—Commended for richness of design, great harmony in its lines; singularly expressive of its purpose for a great State building.

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91. Gambrill & Richardson, New York, N. Y., U. S.

ARCHITECTURAL DESIGNS.

Report.—Commended for great fertility of invention and general good treatment; Trinity Church, Boston, and competitive design for Town Hall, Brookline, with Sherman Cottage, at Newport, particularly specified, the Town Hall being singularly bold and happy in treatment.

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92. Sturgis & Brigham, Boston, Mass., U. S.

DESIGN FOR COURT BUILDINGS.

Report.—Commended for general excellence of design.

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93. Carl Pfeiffer, New York, N. Y., U. S.

ARCHITECTURAL DESIGNS.

Report.—Commended for happy and picturesque treatment of various designs submitted.

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94. L. Marcotte & Co., New York, N. Y., U. S.

INTERIOR WALL DECORATION.

Report.—Commended for great richness of wall decoration, harmonious arrangement of color in same, and general good taste which has governed its preparation.

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95. Wm. H. Jackson & Co., New York, N. Y., U. S.

GRATES AND CHIMNEY APPURTENANCES IN METAL.

Report.—They show artistic treatment of the common appliances of the hearth and fireside. The metal work is skillfully done, and the accompanying decorative features are in excellent taste and appear to us deserving of award as contributing to the furtherance of artistic interior decoration of homes.

96. Henry Fernbach, New York, N. Y., U. S.

ARCHITECTURAL DESIGNS.

Report.—Commended for most careful classic treatment of Renaissance buildings; also very artistic management of polychromatic decoration of interiors.

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97. S. J. F. Thayer, Boston, Mass., U. S.

ARCHITECTURAL DESIGN.

Report.—Commended for bold and excellent treatment of design for Town Hall, Providence.

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98. Kaiser & Herzog, Philadelphia, Pa., U. S.

DECORATION BY FRESCO.

Report.—Commended for judicious assemblage of colors, delicacy of design, excellent taste in execution. Completed works, as well as designs, are submitted.

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99. Ware & Van Brunt, Boston, Mass., U. S.

ARCHITECTURAL DESIGNS.

Report.—Commended for the design of Memorial Hall, Cambridge, Massachusetts, combining simplicity in ground plan and monumental effect of interior. Original and well-studied façade of dwelling-house.

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100. T. H. Wyatt, London, England.

DESIGNS FOR COUNTRY AND TOWN HOUSES.

Report.—Commended for excellent classic treatment of the large designs exhibited, and very pleasing composition as regards form and color, for the country house of Mr. Morant.

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101. William Burgess, F. R. S. B. A., London, England.

DESIGN FOR NEW TOWER AT CARDIFF, NEW LAW COURTS.

Report.—Commended for their careful study and artistic treatment of exteriors.

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102. F. C. Penrose, M. A. F. R. A. S., London, England.

DESIGN FOR DECORATION OF ST. PAUL'S CUPOLA.

Report.—Commended for general excellence of treatment, the designs being in harmony with the style of the cathedral.

---

103. Henry Cooper, London, England.

INTERIOR DECORATION OF ST. GEORGE'S HOUSE.

Report.—Attention is called to the very effective and highly artistic decoration of the interior of St. George's House, built by the British Commissioners.

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104. Wright & Mansfield, London, England.

DECORATION OF INTERIOR.

Report.—Commended for the artistic execution of the decoration of the side of a drawing-room in the style of the latter part of the eighteenth century.

105. Geo. Aitchison, F.R.I.B.A., Tower Hill, London, England.

INDUSTRIAL DESIGN (FURNITURE).

Report.—Commended for good taste in design and faithful elaboration of details. We particularly designate the "sewing table" and the studies for ceilings and walls of "drawing-room."

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106. Sung Sing Kung, Ningpo, China.

GATEWAY.

Report.—The gateway erected in the nave of the Main Building, at the entrance to their exhibition.

---

107. Architect of Japanese Commission.

JAPANESE HOUSES (ON EXHIBITION GROUNDS).

Report.—Commended for the beautiful treatment of wood and admirable joinery in the erection of these buildings, in the graceful lines of roofs and porches, the perfect tile work upon the same, and the rich ornamental carving, altogether offering a capital and most improving study to the careless and slip-shod joiners of the Western world.

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108. A. Crepinet, Paris, France.

DESIGN FOR CATHEDRAL.

Report.—Commended for great beauty of design, the ornamental details showing careful and artistic study.

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109. Viollet Leduc, Paris, France.

ARCHITECTURAL DESIGNS.

Report.—Commended for skill in execution, excellence and fecundity of design. We also name as a controlling reason for suggesting this award the exceptionally happy influence which his books and designs have wrought in stimulating public taste and directing and extending public knowledge in regard to the subject matter of his treatises.

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110. Louis De Curte, Brussels, Belgium.

ARCHITECTURAL DESIGN: GOTHIC CATHEDRAL.

Report.—Commended for excellence of design and faithful and conscientious elaboration of details.

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111. José Marin Baldo, Madrid, Spain.

DESIGN FOR A MONUMENT.

Report.—Commended for a very large design for a monument with centre dome and columns at each side, showing beauty and originality.

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112. The Spanish Government, Madrid, Spain.

ARCHITECTURAL MONUMENTS OF SPAIN.

Report.—This work is valuable and important, describing and illustrating by engravings the most important monumental buildings in Spain, and must prove of great use to architects as a book of reference.

113. Ramon Tenas, Barcelona, Spain.

DESIGN FOR A CHURCH.

Report.—Commended for a very beautiful design for a church in the Gothic style; the various parts in good proportion, and the details carefully studied.

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114. Antonio Rovira y Ravasa, Barcelona, Spain.

DESIGN FOR A MONUMENT.

Report.—Commended for very graceful architectural design in the Moorish style, in fine proportions, with details carefully studied.

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115. Spanish Government.

ARCHITECTURAL FAÇADE.

Report.—Commended for the handsome façade erected in the nave, at the entrance to the Spanish department, Main Building.

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116. Egyptian Government.

INSTALLATION OF EXHIBIT.

Report.—Commended for excellent taste and construction.

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117. M. Daninos, Egypt.

ANCIENT DOOR.

Report.—Curious and very rich decorarive work of the fourteenth century; commendable for its artistic character.

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118. Regency of Tunis.

DECORATED SCREEN AND INCLOSURE.

Report.—Commended for the richly decorated screen and inclosure in the Moorish style, which has increased the beauty and interest of their exhibit.

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119. Empire of Brazil.

ARCHITECTURAL SCREEN AND INCLOSURE (INSTALLATION).

Report.—Commended for characteristic style and suitable decoration and excellent taste.

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120. Danish Government.

INSTALLATION OF EXHIBIT.

Report.—Commended for the ornamental archway erected in the nave, at the entrance to the Danish exhibit.

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121. Chr. Hetsch, Copenhagen, Denmark.

VARIOUS INDUSTRIAL DESIGNS.

Report.—Commended for the utility and good taste of various industrial designs of wide application.

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122. Hugo Licht, Berlin, Germany.

ARCHITECTURAL DESIGNS.

Report.—Gartenhalle, Berlin, appearing as a photographic exhibit, is a free, bold, artistic design, showing charming management of details, both as regards exterior and interior.

123. Theophil Ritter von Hansen, Vienna, Austria.

ARCHITECTURAL ERECTIONS IN VIENNA.

Report.—Commended for general excellence of design.

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124. Lud. Fischler, Vienna, Austria.

ARCHITECTURAL DESIGNS.

Report.—Commended for general excellence of design.

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125. Heinrich Ritter von Ferstel, Vienna, Austria.

ARCHITECTURAL DESIGNS.

Report.—Commended for general excellence, both in classic and medieval architecture.

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126. Friedrich Schmidt, Vienna, Austria.

ARCHITECTURAL (GOTHIC) DESIGNS.

Report.—Commended for general excellence of design.

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127. Norwegian Government.

FRAMED INCLOSURE OF WOOD (INSTALLATION).

Report.—Commended for the very elegant and appropriate framing of wood which forms the inclosure of the space allowed to Norway.

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128. Government of the Netherlands.

SCREEN.

Report.—Commended for the very elegant and well-proportioned screen erected on the side of the nave of the Main Building.

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129. Swedish Commission.

SWEDISH SCHOOL-HOUSE.

Report.—Commended for its simple and severe use of homely materials, all being so managed as to subserve admirably the purposes of the erection. To be commended to the attention of our public school committees, as teaching simplicity and homeliness as opposed to extravagant ornamentation.

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130. N. M. Mandelgren, Stockholm, Sweden.

DESIGN FOR CHURCH DECORATION.

Report.—Commended for the careful study and happy presentation of the best medieval features of architectural decorative work.

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131. Government of Sweden.

ARCH CONSTRUCTED OF WOOD (INSTALLATION).

Report.—Commended for the tastefully constructed arch of wood, flanked by a porch on each side, characteristic of the style of the country.

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132. Swiss Government.

INSTALLATION OF EXHIBIT.

Report.—Commended for excellent taste and good construction.

133. S. Slack & Co., Orange, N. J., U. S.

STAINED GLASS WINDOWS.

Report.—Fairly harmonious in color, and the general treatment quite artistic. Effect, without being rich or brilliant, is pleasing. The two circlets in the left compartment are ingeniously composed. Well-managed ruby tints in central lozenge, but its drawing crude and hard.

134. Arthur Fitzpatrick & Co., Staten Island, N. Y., U. S.

STAINED GLASS.

Report.—Designating particularly the centre panel of the easternmost window in the Annex to Memorial Hall, as being good in composition and harmonious in its coloring and giving fair evidence of progress in this branch of American art. This exhibit suffers by a misarrangement of its parts, the specimens being so arranged as to give the impression of a single window made up of very discordant features.

135. John Hardman & Co., Birmingham, England.

STAINED GLASS WINDOW.

Report.—Commended for good drawing; harmonious color; great clearness of tint. Great awkwardness in results, from introducing a lighted ceiling in perspective, but the general work excellent in manner, and according with the best traditions of the art of glass staining.

136. William Ramsey, London, England.

WINDOW SCREENS OF STAINED GLASS.

Report.—The screens are excellent in designs, and treated with such monochromatic and translucent tints as greatly favor their adoption for domestic uses. Thus, without undue sacrifice of light, this art may be made to minister very happily to household decoration.

137. Heaton, Butler, & Bayne, London, England.

STAINED GLASS.

Report.—Commended for the admirable drawing and generally effective treatment, and more especially for the artist's bold seizure upon homely subjects, thus opening the way for a happy adaptation of this art to purposes of domestic decoration.

138. Hovenden & Meldrum, Toronto, Ontario, Canada.

PAINTING ON GLASS.

Report.—Commended for merit of the specimens of sign painting on glass, which are of good and effective designs for the purpose and well executed, producing an agreeable decorative effect.

139. William J. Booth, Toronto, Ontario, Canada.

SIGN PAINTING ON GLASS.

Report.—Commended for artistic execution, good design; very agreeable in general effect.

140. J. C. Spence, Montreal, Canada.

WINDOW OF STAINED GLASS.

Report.—Commended for fair elaboration of details, translucence, general effectiveness, and artistic execution.

141. A. Walker, Halifax, Nova Scotia.

GILDING ON GLASS.

Report.—The specimen of gold decoration on glass, the designs of which are taken from the Loggie of the Vatican, is extremely well executed, and is suggestive of the introduction of this mode of decoration where suitable, which would be durable and easily kept clean.

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142. A. Lorin, Chartres, France.

STAINED GLASS: CHURCH WINDOWS.

Report.—Commended for great merit in the drawing, brilliancy of coloring, although somewhat overcharged in the shadows. We also name as worthy of commendation the skillful and adroit management of the "leadings." The work is one of great magnitude and importance, though seen at immense disadvantage in the cramped building which has been erected by the exhibitor for its display.

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143. F. X. Zettler, Munich, Germany.

STAINED GLASS CHURCH WINDOW (MEMORIAL HALL).

Report.—Commended for great brilliancy of effect and general artistic treatment, particularly of its arabesque ornamentation in the subsidiary parts. It may be noted that the character of this work shows an advantageous abandonment of the faulty principles of glass painting which have for some years past prevailed at Munich.

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144. Miss Isabella Gifford, Syracuse, N. Y., U. S.

SCULPTURE.

Report.—Commended for artistic excellence in sculpture of the bust.

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145. Montague Hanley, U. S.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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146. E. D. Palmer, Albany, N. Y., U. S.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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147. John Rogers, New York, N. Y., U. S.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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148. H. Roberts, Philadelphia, Pa., U. S.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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149. Alfred Ross, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

150. Anatole Marquet de Vasselot, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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151. Hippolyte Moulin, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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152. Joseph Michel Caillé, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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153. Charles Cordier, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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154. Jules Cambos, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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155. Cyprien Godebski, Paris, France.

SCULPTURE: BUST.

Report.—Commended for artistic excellence in the fine art of sculpture.

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156. Augustin Moreau Vauthier, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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157. A. D. Doublemard, Paris, France.

SCULPTURE.

Report.—Commended for artistic excellence in the figure.

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158. Pierre Jules Mene, Paris, France.

SCULPTURE: GROUP IN BRONZE.

Report.—Commended as very well composed and admirably executed.

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159. Jules Dalou, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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160. Frederic Auguste Bartholdi, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

161. Jules Blanchard, Paris, France.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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162. Antoine Felix Bouré, Brussels, Belgium.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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163. Charles Auguste Fraiken, Brussels, Belgium.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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164. Adolphe Fassin, Brussels, Belgium.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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165. Geronimo Suñol, Barcelona, Spain.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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166. Rosendo Nobas, Barcelona, Spain.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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167. Bernadelli A. Espreita, Brazil.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence.

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168. Giovanni Spertini, Milan, Italy.

SCULPTURE: BUST.

Report.—Commended for artistic excellence in the fine art of sculpture.

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169. W. W. Story, Rome, Italy.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence.

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170. Renato Peduzzi, Milan, Italy.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence.

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171. Raimondo Pereda, Milan, Italy.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

172. **Emilio Zocchi, Florence, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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173. **Salvino Salvini, Bologna, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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174. **Michele Buoninsegna, Milan, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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175. **Donato Barcaglia, Milan, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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176. **Antonio Bottinelli, Rome, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence.

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177. **Francesco Barzaghi, Milan, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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178. **Pietro Calvi, Milan, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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179. **Pietro Guarnerio, Milan, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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180. **Giosné Argenti, Milan, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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181. **Lot Torelli, Florence, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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182. **Bastianini, Florence, Italy.**

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

183. Fried. Reusch, Berlin, Germany.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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184. Caspar Zumbusch, Vienna, Austria.

SCULPTURE: BUST.

Report.—Commended for artistic excellence in the fine art of sculpture.

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185. N. Plaza, Chueca, Chili.

SCULPTURE IN BRONZE: THE FIGURE.

Report.—Commended for artistic excellence.

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186. J. Börjeson, Sweden.

SCULPTURE: THE FIGURE.

Report.—Commended for artistic excellence in the fine art of sculpture.

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187. American Bank Note Co., New York, N. Y., U. S.

ENGRAVING.

Report.—Commended for the promotion of excellent and artistic engravings.

---

188. The School of Henry L. and Wm. H. Fry, Cincinnati, Ohio, U. S.

WOOD CARVING.

Report.—Commended for graceful designs and excellent workmanship.

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189. School of Design of the University of Cincinnati, Cincinnati, Ohio, U. S.

WOOD CARVING.

Report.—Commended for tasteful designs and good workmanship.

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190. National Bank Note Co., New York, N. Y., U. S.

ENGRAVING.

Report.—Commended for excellence in engraving.

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191. A. B. Durand, New York, N. Y., U. S.

ENGRAVING.

Report.—Commended for excellence in engraving.

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192. H. H. Nichols, Washington, D. C., U. S.

WOOD ENGRAVINGS.

Report.—Commended for excellent surgical engravings on wood.

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193. James W. Lauderbach, Philadelphia, Pa., U. S.

WOOD ENGRAVINGS.

Report.—Commended for excellence in engraving on wood.

194. J. S. Harley, New York, N. Y., U. S.

WOOD ENGRAVING.

Report.—Commended for excellence in wood engraving.

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195. Stroefer & Kirchner, New York, N. Y., U. S.

ENGRAVINGS.

Report.—Commended for promoting excellence in engraving.

---

196. Continental Bank Note Co., New York, N. Y., U. S.

ENGRAVINGS.

Report.—Commended for the promotion of excellent and artistic engravings.

---

197. W. E. Marshall, New York, N. Y., U. S.

LINE ENGRAVING.

Report.—Commended for excellence in engraving.

---

198. J. Saddler, England.

WOOD ENGRAVING.

Report.—Commended for firm, vigorous, and finely-executed wood engravings.

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199. T. Oldham Barlow, A. R. A., England.

ENGRAVINGS.

Report.—Commended for excellence in execution and firmness in tone

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200. C. G. Lewis, England.

ENGRAVINGS.

Report.—Commended for excellence in reproducing the characteristic merits of paintings.

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201. Joseph Swain, England.

WOOD ENGRAVING.

Report.—Commended for excellence in wood engraving; firm, vigorous, and delicate expression.

---

202. Sung Sing Kung, Ningpo, China.

WOOD CARVING.

Report.—Commended for screen of a very good style and good taste; excellent execution.

---

203. Ho A Ching, Canton, China.

CARVING IN IVORY.

Report.—Commended for excellent workmanship in ivory; ornamentation rich and finely executed; figures good.

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204. Fow Loong, Canton, China.

WOOD CARVING.

Report.—Commended for paravents of good style and excellent execution.

205. First Japanese Manufacturing and Trading Co., Tokio, Japan.

CARVINGS IN WOOD AND IVORY.

Report.—Remarkable carvings in wood and ivory.

206. Marunaka Magohei, Kanazawa, Japan.

BRONZE, WITH INCRUSTATIONS.

Report.—Excellent workmanship, and refined in style.

207. Nagishi Manzo, Tokio, Japan.

WOOD CARVING: WARDROBE.

Report.—Commended for excellent design and workmanship; moderately charged in ornamentation.

208. Count George von Rosen, Stockholm, Sweden.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait.

209. C. Laplante, Paris, France.

WOOD ENGRAVING.

Report.—Commended for excellent execution and richness of tone and good design.

210. Hachette & Co., Paris, France.

ENGRAVINGS AND ETCHINGS, AND WOOD ENGRAVINGS.

Report.—Commended for promoting excellence in engraving, etching, and wood engraving.

211. Charpentier, Paris, France.

ENGRAVINGS AND ETCHINGS.

Report.—Commended for promoting excellence in engravings and etchings.

212. Claude Gaillard, Paris, France.

ENGRAVING.

Report.—Commended for artistic excellence in engraving.

213. E. Thomas, Paris, France.

WOOD ENGRAVING.

Report.—Commended for richness of tone and vigorous and excellent execution.

214. J. Bauduy, Paris, France.

ENGRAVINGS AND ETCHINGS.

Report.—Commended for excellence in engravings and etchings and architectural publications.

215. Gustave Biot, Brussels, Belgium.

ENGRAVING.

Report.—Commended for excellence in engraving.

216. Goyers Brothers, Louvain, Belgium.

WOOD CARVING.

Report.—Church chairs, of artistic design and good workmanship.

217. Ramon Subirat, Madrid, Spain.

WOOD SCULPTURE.

Report.—Figure of Christ on the Cross. Figure good; large movement and excellent workmanship.

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218. The Spanish Illustration, Madrid, Spain.

WOOD ENGRAVING.

Report.—Commended for excellence in wood engraving.

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219. Academy of Fine Arts, Madrid, Spain.

ENGRAVINGS AND ETCHINGS.

Report.—Commended for excellent specimens of engravings and etchings.

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220. Joseph Parvis, Cairo, Egypt.

WOOD CARVING.

Report.—Nice workmanship, an armoire in Oriental style of artistic feeling.

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221. Rinaldo Barbetti, Florence, Italy.

WOOD CARVING: A PRIE-DIEU.

Report.—Commended for artistic design and excellent workmanship.

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222. Prof. Cav. Luigi Frullini, Florence, Italy.

WOOD CARVING.

Report.—Chimney piece, style Renaissance; carving of a high artistic order of merit; design good.

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223. Romanelli Ferdinand, Florence, Italy.

WOOD CARVING.

Report.—Commended for frame-work of carving, delicate, and executed with much beauty.

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224. Alexander Duncker, Berlin, Germany.

ENGRAVING.

Report.—Commended for promoting excellence in engraving.

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225. Nicolaus Barthelmess, Düsseldorf, Germany.

ENGRAVING.

Report.—Commended for excellence in execution and clearness of tone and artistic merit.

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226. A. Krausse, Leipsic, Germany.

ENGRAVING.

Report.—Commended for excellence of execution and tone, and artistic merit.

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227. Peter Kaeser, Vienna, Austria.

ENGRAVINGS AND ETCHINGS.

Report.—Commended for the promotion of excellent and artistic work in engraving and etching.

228. Francis Unterberger, Innsbruck, Tyrol, Austria.

WOOD CARVING.

Report.—Subject in bas-relief; work excellent, showing great delicacy and sentiment of feeling; also for haut-relief; interior, same quality as above.

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229. C. von Bergen & Co., Interlaken, Switzerland.

WOOD CARVING.

Report.—Eagle; good style, large in movement, and finely executed.

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230. Jb. Jäger & Co., Brienz, Switzerland.

WOOD CARVING.

Report.—Group of goat and dogs; well executed, and cut with much lightness and delicacv; design excellent.

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231. P. Moran, Philadelphia, Pa., U. S.

ETCHINGS.

Report.—Commended for excellence in design and execution.

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232. Edwin Forbes, New York, N. Y., U. S.

ETCHINGS.

Report.—Commended for excellent studies from nature and life, firmness in tone, and spirited execution.

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233. P. A. Rajon, Paris, France, and London, England.

ETCHINGS.

Report.—Commended for vigorous execution and richness of tone.

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234. John Leighton, F. S. A., London, England.

ETCHINGS PRINTED FROM RELIEF.

Report.—Commended for excellence in workmanship.

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235. Edwin Edwards, England.

ETCHINGS.

Report.—Commended for excellent specimens of etchings.

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236. Arthur Evershed, England.

DRY-POINT ETCHINGS.

Report.—Commended for excellent specimens of etchings.

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237. Francis Seymour, Haden, England.

ETCHINGS ON COPPER.

Report.—Commended for excellent specimens of etchings; boldly etched; great spirit shown.

238. J. P. Heseltine, England.

ETCHINGS.

Report.—Commended for excellence in etching.

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239. Jules Adeline, Paris, France.

ETCHINGS.

Report.—Commended for excellence in design and execution and firmness in tone.

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240. Gazette des Beaux-Arts, Paris, France.

ETCHINGS AND ENGRAVINGS.

Report.—Commended for the promotion of excellent and artistic work in engraving and etching.

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241. M. Lalanne, Paris, France.

ETCHINGS AND CHARCOAL DRAWINGS.

Report.—Commended for excellence in execution and firmness of tone, good atmospheric effect, and delicacy of handling, in both etching and charcoal drawing.

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242. A. Ballue, Paris, France.

ETCHINGS.

Report.—Commended for excellence of artistic etchings.

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243. L. Flameng, Paris, France.

ETCHINGS.

Report.—Commended for excellent execution and refinement in design.

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244. A. Brunet-Debaines, Paris, France.

ETCHINGS.

Report.—Commended for exceedingly fine execution and delicacy of handling, firmness and clearness of tone, being of a high artistic order of merit.

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245. Léon Gaucherel, Paris, France.

ETCHINGS.

Report.—Commended for delicacy of handling and artistic grace in design and movement of figures, and for clearness of tone.

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246. Juan Martinez Espinosa, Madrid, Spain

ETCHINGS.

Report.—Commended for excellent and artistic etchings.

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247. Bartolomé Maura, Madrid, Spain.

ETCHINGS.

Report.—Commended for excellent and artistic etchings.

248. William Unger, Vienna, Austria.

ETCHINGS.

Report.—Commended for excellence in execution and firmness of tone.

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249. J. R. Osgood & Co., Boston, Mass., U. S.

HELIOGRAPHS.

Report.—Commended for heliographs.

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250. F. A. Wenderoth, Philadelphia, Pa., U. S.

HELIOGRAPHS.

Report.—Commended for heliographs.

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251. John Carbutt, Philadelphia, Pa., U. S.

HELIOGRAPHS AND PHOTO-LITHOGRAPHS.

Report.—Commended for good heliographs and photo-lithographs.

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252. Gillot's Widow & Son, Paris, France.

HELIOGRAPHY.

Report.—Commended for heliotypes on zinc for block printing.

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253. Photographic Society, Berlin, Germany.

HELIOGRAPHS.

Report.—Commended for photographic reproductions of oil painting.

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254. Strumper & Co., Hamburg, Germany.

HELIOTYPES.

Report.—Commended for lichtdrucks.

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255. Römmler & Jonas, Dresden, Germany.

HELIOGRAPHS.

Report.—Commended for quick-acting press lichtdrucks.

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256. Brauneck & Maier, Mentz, Germany.

HELIOGRAPHY.

Report.—Commended for rapid-acting lichtdruck process.

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257. C. H. Jacobi, Berlin, Germany.

HELIOGRAPHY.

Report.—Commended for lichtdruck pictures.

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258. J. Albert, Munich, Germany.

HELIOGRAPHY.

Report.—Commended for invention and improvements in lichtdruck.

259. J. G. V. Carleman, Stockholm, Sweden.

HELIOGRAPHS.

Report.—Commended for heliographic experiments.

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260. American Photo-Lithographic Co., New York, N. Y., U. S.

PHOTO-LITHOGRAPHS.

Report.—Commended for technical excellence of photo-lithographs.

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261. Prang & Co., Boston, Mass., U. S.

CHROMO-LITHOGRAPHS.

Report.—Commended for excellence in chromo-lithographs.

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262. Joseph Hoover, Philadelphia, Pa., U. S.

CHROMO-LITHOGRAPHS.

Report.—Commended for meritorious work in chromo-lithographs.

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263. Chas. Paxson & Brother, New York, N. Y., U. S.

SOLAR PRINTS.

Report.—Commended for plain solar enlarged prints.

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264. American Photo-Relief & Printing Co., Philadelphia, Pa., U. S.

PHOTO-RELIEF PRINTS.

Report.—Commended for photo-relief prints on glass.

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265. Cassel, Petter, & Galpin, London, England.

LITHOGRAPHS AND CHROMO-LITHOGRAPHS.

Report.—Commended for artistic excellence in lithography and chromo-lithography, works on ornament.

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266. Marcus Ward & Co., London, England.

CHROMO-LITHOGRAPHIC ILLUSTRATIONS.

Report.—Commended for excellent and artistic specimens of book illustrations.

---

267. A. Le Gras, Paris, France.

CHROMO-LITHOGRAPHS.

Report.—Commended for excellence in chromo-lithography.

---

268. A. Duche & Co., Paris, France.

CHROMO-LITHOGRAPHS.

Report.—Commended for excellence in architectural publications.

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269. Marcos Lutles, Madrid, Spain.

ELECTRO PLATE.

Report.—Commended for work of remarkable artistic excellence in design and execution.

270. Inocencio Arce, Barcelona, Spain.

PHOTO-LITHOGRAPHS.

Report.—Commended for excellent specimens of photo-lithographs.

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271. Benedetto Domenico Gravina, Palermo, Italy.

CHROMO-LITHOGRAPHY.

Report.—Commended for excellence of chromo-lithography, works on architecture.

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272. Library Spithöver, Rome, Italy.

CHROMO-LITHOGRAPHS.

Report.—Commended for excellent specimens of ancient mosaics.

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273. R. Steinbock & W. Loeillot, Berlin, Germany.

CHROMO-LITHOGRAPHY.

Report.—Commended for superior and artistic specimens of chromo-lithographs.

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274. Böehme & Fraenkel, Berlin, Germany.

CHROMO-LITHOGRAPHS.

Report.—Commended for excellence in chromo-lithographs.

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275. Brückner & Co., Munich, Germany.

CHROMO-LITHOGRAPHY.

Report.—Commended for excellence in chromo-lithography.

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276. Storch & Kramer, Berlin, Germany.

CHROMO-LITHOGRAPHY.

Report.—Commended for excellence in chromo-lithography.

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277. Rieffenstein & Roesch, Vienna, Austria.

CHROMO-LITHOGRAPHS.

Report.—Commended for excellence in chromo-lithography.

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278. De Maurier, London, England.

DRAWINGS WITH PEN.

Report.—Commended for excellence in design, firmness in execution, and high character in style.

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279. London Graphic Co., London, England.

DRAWINGS AND WOOD ENGRAVINGS.

Report.—Commended for the promotion of excellence in design and engravings, and for their superior collection of original designs.

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280. J. J. Bellel, Paris, France.

CHARCOAL DRAWING.

Report.—Commended for beauty of style, excellence of design and execution, strength and richness of tone.

281. J. Henry Brown, Philadelphia, Pa., U. S.

MINIATURE PORTRAITS.

Report.—Good, and commended as among the best in the American section.

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282. Imperial Artistical Institute, Brazil.

COLORED DRAWINGS OF BIRDS AND INDIAN ARMS.

Report.—Commended for excellence in design and truthfulness of color.

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283. Broadbent & Phillips, Philadelphia, Pa., U. S.

PHOTOGRAPHS.

Report.—Commended for plain photographs.

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284. G. W. Pach, New York, N. Y., U. S.

PHOTOGRAPHS.

Report.—Commended for photographs of groups and horses.

---

285. Centennial Photographic Co., Philadelphia, Pa., U. S.

PHOTOGRAPHS.

Report.—Commended for good photographs of interiors, buildings, and engines.

---

286. Thomas Gaffield, Boston, Mass., U. S.

PHOTOGRAPHS.

Report.—Commended for leaf prints and photo-chemical researches.

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287. Schreiber & Son, Philadelphia, Pa., U. S.

PHOTOGRAPHS OF ANIMALS.

Report.—Commended for plain photographs of animals.

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288. J. W. Black, Boston, Mass., U. S.

PHOTOGRAPHS.

Report.—Commended for Arctic views.

---

289. J. F. Ryder, Cleveland, Ohio, U. S.

PHOTOGRAPHS.

Report.—Commended for skillful crayon work.

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290. Thomas Houseworth, San Francisco, Cal., U. S.

PHOTOGRAPHS.

Report.—Commended for artistic excellence of landscape photographs.

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291. Charles Bierstadt, Niagara Falls, N. Y., U. S.

PHOTOGRAPHS.

Report.—Commended for excellent stereoscopic pictures.

292. Allman & Co., New York, N. Y., U. S.

PHOTOGRAPHS.

Report.—Commended for plain photographs and cloud-pictures.

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293. Henry Rocher, Chicago, Ill., U. S.

PHOTOGRAPHS.

Report.—Commended for artistic excellence in plain portraits and genre photographs.

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294. D. H. Anderson, Richmond, Va., U. S.

PHOTOGRAPHS.

Report.—Commended for good plain portrait photographs.

---

295. C. E. Watkins, San Francisco, Cal., U. S.

PHOTOGRAPHS.

Report.—Commended for artistic excellence of landscape photographs.

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296. W. J. Marshall, Fitchburg, Mass., U. S.

PHOTOGRAPHS.

Report.—Commended for photographs of scenery in the Yellowstone Park.

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297. Bradley & Rulofson, San Francisco, Cal., U. S.

PHOTOGRAPHS AND CRAYONS.

Report.—Commended for good landscape photographs and crayon portraits.

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298. A. Hesler, Evanstown, Ill., U. S.

PHOTOGRAPHS.

Report.—Commended for children's portraits.

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299. C. S. Mosher, Chicago, Ill., U. S.

PHOTOGRAPHS.

Report.—Commended for good portrait photographs.

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300. Allen & Rowell, Boston, Mass., U. S.

PHOTOGRAPHS.

Report.—Commended for carbon prints.

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301. N. Sarony, New York, N. Y., U. S.

PHOTOGRAPHS.

Report.—Commended for artistic excellence in plain portrait photographs and charcoal drawing.

---

302. Dr. J. J. Woodward, Washington, D. C., U. S.

PHOTOGRAPHS.

Report.—Commended for excellence of micro-photographs.

303. J. Landy, Cincinnati, Ohio, U. S.

PHOTOGRAPHS.

Report.—Commended for photographs of children, and plain portraits.

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304. W. Kurtz, New York, N. Y., U. S.

PHOTOGRAPHS.

Report.—Commended for general artistic excellence in all styles of portrait photographs, plain, crayon, oil, and pastel, and for a new process of making durable transfer crayons.

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305. J. H. Kent, Rochester, N. Y., U. S.

PHOTOGRAPHS.

Report.—Commended for good photographs from large direct negatives.

---

306. Carl Seiler, Philadelphia, Pa., U. S.

PHOTOGRAPHS.

Report.—Commended for good micro-photographs.

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307. John Reid, Paterson, N. J., U. S.

PHOTOGRAPHS.

Report.—Commended for good photographs of bridges and engines.

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308. C. A. Zimmerman, Minn., U. S.

PHOTOGRAPHS.

Report.—Commended for photographs of Indians.

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309. L. G. Bigelow, Detroit, Mich., U. S.

PHOTOGRAPHS.

Report.—Commended for photographic art publications.

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310. A. Henderson, London, England.

PHOTOGRAPHS.

Report.—Commended for photo-enamels.

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311. William Bedford, London, England.

PHOTOGRAPHS.

Report.—Commended for artistic landscape photographs.

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312. Vernon Heath, London, England.

PHOTOGRAPHS.

Report.—Commended for artistic and technical excellence of large landscape, photographs by the carbon process.

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313. Colonel Stuart Wortley, London, England.

PHOTOGRAPHS.

Report.—Commended for artistic landscape studies and technical excellence of uranium dry plates.

314. Julia Margaret Cameron, Isle of Wight, England.

PHOTOGRAPHS.

Report.—Commended for good taste and artistic composition of photographs.

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315. H. P. Robinson, Leamington, England.

PHOTOGRAPHS.

Report.—Commended for artistic excellence of landscape studies.

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316. Frederick York, London, England.

PHOTOGRAPHS.

Retort.—Commended for stereoscopic photographs of animals.

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317. Carl Norman, Tunbridge Wells, England.

PHOTOGRAPHS.

Report.—Commended for good landscape photographs.

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318. The London Stereoscopic and Photographic Co., London, England.

PHOTOGRAPHS.

Report.—Commended for imperial-size photographs.

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319. Frederick Hudson, Ventnor, Isle of Wight, England.

PHOTOGRAPHS.

Report.—Commended for artistic landscape photographs.

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320. Payne Jennings, Dublin, Ireland.

PHOTOGRAPHS.

Report.—Commended for the highest artistic excellence in landscape photography.

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321. J. Hubert Newman, Australia.

PHOTOGRAPHS.

Report.—Commended for portrait photographs.

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322. B. O. Haltemann, Sydney, New South Wales, Australia.

PHOTOGRAPHS.

Report.—Commended for large panoramic photographs.

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323. John Sharkey, Sydney, New South Wales, Australia.

PHOTOGRAPHS.

Report.—Commended for photo-lithography.

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324. W. T. Lindt, Grafton, New South Wales, Australia.

PHOTOGRAPHS.

Report.—Commended for good landscape photographs

325. Richard Daintree, Queensland, Australia.

PHOTOGRAPHS.

Report.—Commended for colored photographs of landscapes and objects of scientific interest.

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326. John Chambers, New Zealand.

PHOTOGRAPHS.

Report.—Commended for photographs of the geysers.

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327. W. Notman, Montreal, Canada.

PHOTOGRAPHS.

Report.—Commended for artistic excellence of photographs from life and hunting groups.

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328. Charles Bergamasco, St. Petersburg, Russia.

PHOTOGRAPHS.

Report.—Commended for fine card-size photographs.

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329. John Meczkowski, Warsaw, Russia.

PHOTOGRAPHS.

Report.—Commended for large photographs direct from life.

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330. Andrew-Karelin, Nijni Novgorod, Russia

PHOTOGRAPHS.

Report.—Commended for large photographs direct from life.

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331. Kostka & Mullert, Warsaw, Russia.

PHOTOGRAPHS.

Report.—Commended for large photographic portraits direct from life.

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332. B. Jaworsky, Russia.

PHOTOGRAPHS.

Report.—Commended for well-executed photographs of Algerian life.

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333. E. Eli, Warsaw, Russia.

PHOTOGRAPHS.

Report.—Commended for skillful painting of photographs in colors.

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334. Baron Stillfried, Yokohama, Japan.

PHOTOGRAPHS.

Report.—Commended for excellent landscape and genre pictures of Japanese life.

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335. Walery, Paris, France.

PHOTOGRAPHS.

Report.—Commended for artistic portrait photographs.

336. **W. de Bray, Nice, France.**

PHOTOGRAPHS.

Report.—Commended for artistic landscape studies.

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337. **A. Liebert, Paris, France.**

PHOTOGRAPHS.

Report.—Commended for artistic portraits by the carbon process.

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338. **Léon Vidal, Paris, France.**

PHOTOGRAPHS.

Report.—Commended for reproductions of industrial works of art in color.

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339. **J. Levy & Co., Paris, France.**

PHOTOGRAPHS.

Report.—Commended for very good photographic transparencies on glass.

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340. **Beernaert Brothers, Ghent, Belgium.**

PHOTOGRAPHS.

Report.—Commended for carbon prints.

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341. **Laurent & Co., Madrid, Spain.**

PHOTOGRAPHS.

Report.—Commended for reproductions of oil paintings and architectural photographs.

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342. **Eduardo Diaz Otero, Madrid, Spain.**

PHOTOGRAPHS.

Report.—Commended for portrait photographs.

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343. **Francisco Rochini, Lisbon, Portugal.**

PHOTOGRAPHS.

Report.—Commended for architectural photographs.

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344. **Antonio Correa da Fonseca, Oporto, Portugal.**

PHOTOGRAPHY.

Report.—Commended for portraits.

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345. **Emilio Biel, Oporto, Portugal.**

PHOTOGRAPHY.

Report.—Commended for artistic portraits.

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346. **Fernandes Souza, Oporto, Portugal.**

PHOTOGRAPHY.

Report.—Commended for micro-photographs.

6

347. Carlos Relvas, Lisbon, Portugal.

PHOTOGRAPHS.

Report.—Commended for technical excellence in different processes.

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348. Cruces y Campa, City of Mexico, Mexico.

PHOTOGRAPHS.

Report.—Commended for photographic portraits.

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349. Beato, Cairo, Egypt.

PHOTOGRAPHS.

Report.—Commended for large photographic landscapes of great technical excellence.

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350. O. Schoefft, Cairo, Egypt.

PHOTOGRAPHS.

Report.—Commended for artistic genre and architectural photographs.

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351. T. E. Rosenthal, U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in genre:

"Remind me not that I alone
Am cast out from the spring."

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352. Insley Pacheco, Rio Janeiro, Brazil.

PHOTOGRAPHS.

Report.—Commended for chromo-photographs.

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353. Charles F. Hartt, Rio de Janeiro, Brazil.

PHOTOGRAPHS.

Report.—Commended for geological photographs.

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354. Christiano Junior, Buenos Ayres, Argentine Republic.

PHOTOGRAPHS.

Report.—Commended for imperial cards.

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355. Cav. Giacomo Rossetti, Brescia, Italy.

PHOTOGRAPHS.

Report.—Commended for architectural photographs.

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356. Robert Scholz, Görlitz, Germany.

PHOTOGRAPHS.

Report.—Commended for artistic landscapes and architectural studies.

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357. Loescher & Petsch, Berlin, Germany.

PHOTOGRAPHS.

Report.—Commended for artistic excellence in plain portraits and genre photographs.

358. J. B. Obernetter, Munich, Germany.

PHOTOGRAPHS.

Report.—Commended for the lichtdruck pictures.

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359. Bernhard Mischewski, Dantzic, Germany.

PHOTOGRAPHS.

Report.—Commended for good plain portrait photographs.

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360. J. C. Schaarwächter, Berlin, Germany.

PHOTOGRAPHS.

Report.—Commended for artistic excellence in plain portrait photographs.

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361. Schulz & Suck, Carlsruhe, Germany.

PHOTOGRAPHS.

Report.—Commended for good plain portrait photographs.

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362. Franz Heiler, Mosbach, Baden, Germany.

PHOTOGRAPHS.

Report.—Commended for anthropological studies.

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363. Hermann Rückwardt, Berlin, Germany.

PHOTOGRAPHS.

Report.—Commended for excellent architectural photographs.

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364. E. Kiewning, Stettin, Germany.

PHOTOGRAPHS.

Report.—Commended for good plain portrait photographs.

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365. J. I. Koesler, Landeck, Germany.

PHOTOGRAPHS.

Report.—Commended for architectural photographs.

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366. Reichard & Lindner, Berlin, Germany.

PHOTOGRAPHS.

Report.—Commended for good plain portrait photographs.

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367. Franz Largajoli, Meran, Austria.

PHOTOGRAPHS.

Report.—Commended for artistic landscape photographs.

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368. Miss Antonie Bogner, Vienna, Austria.

PHOTOGRAPHS.

Report.—Commended for skillful coloring on paper and glass.

369. Josef Ungar, Vienna, Austria.

PHOTOGRAPHS.

Report.—Commended for children's portraits.

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370. Victor Angerer, Vienna, Austria.

PHOTOGRAPHS.

Report.—Commended for good photographic reproductions of paintings and interiors.

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371. Lewis Schodisch, Oberwarth, Austria.

PHOTOGRAPHS.

Report.—Commended for good photographs of animals.

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372. Frederic Luckhardt, Vienna, Austria.

PHOTOGRAPHS.

Report.—Commended for artistic plain portraits and stereoscopic pictures.

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373. K. Knudsen, Bergen, Norway.

PHOTOGRAPHS.

Report.—Commended for landscape photographs of Lapland.

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374. E. E. Aubert, Christiania, Norway.

PHOTOGRAPHS.

Report.—Commended for photographs of Norwegian popular types.

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375. L. Szacinski, Christiania, Norway.

PHOTOGRAPHS.

Report.—Commended for portraits.

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376. F. Julius von Kolkow, Groningen, Holland.

PHOTOGRAPHS.

Report.—Commended for carbon lantern slides.

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377. H. Osti, Upsala, Sweden.

PHOTOGRAPHS.

Report.—Commended for portrait photography.

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378. I. Jaeger, Stockholm, Sweden.

PHOTOGRAPHS.

Report.—Commended for photographic reproductions.

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379. R. Roesler, Stockholm, Sweden.

HELIOGRAPHS AND PHOTOGRAPHS.

Report.—Commended for heliographs on copper and photographs on wood.

380 Taeschler Brothers, St. Fiden, Switzerland.

PHOTOGRAPHS.

Report.—Commended for artistic photographic portraits.

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381. J. Ganz, Zurich, Switzerland.

PHOTOGRAPHS.

Report.—Commended for photographic portraits.

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382. F. Charnauz, Geneva, Switzerland.

PHOTOGRAPHS.

Report.—Commended for photographs of mountain scenery and panoramas.

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383. The American Society of Painters in Water-Colors.

COLLECTION OF WATER-COLORS.

Report.—Commended for the general excellence of the pictures in the collection of water-colors on exhibition, and for the successful efforts of the Society in the interests of this art.

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384. H. S. Marks, London, England.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence.

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385. L. Alma Tadema, London, England.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence and great beauty in design, color, and tone, and refinement of execution.

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386. J. D. Linton, London, England.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence and rich, full color, excellent design and execution.

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387. J. M. Jopling, London, England.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence.

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388. A. P. Newton, London, England.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence.

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389. W. Callow, London, England.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence.

390. D. Fowler, Canada.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence.

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391. Francis Tepa, Lemberg, Austria.

WATER-COLOR PAINTING.

Report.—Commended for excellence in water-color portraiture, as shown in his picture entitled "The Polish General Josef Zaluski."

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392. Ralph Alt, Vienna, Austria.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence.

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393. Emanuel Stöckler, Vienna, Austria.

WATER-COLOR PAINTING.

Report.—Commended for excellence in water-color genre painting, as shown in his picture, "Fishmonger in Venice."

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394. Miss Anna Gardell, Stockholm, Sweden.

PAINTING IN WATER-COLOR.

Report.—Commended for artistic excellence.

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395. J. B. Bristol, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "Lake Memphremagog."

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396. Emily Sartain, Philadelphia, Pa., U. S.

OIL PAINTING.

Report.—Commended for merit in genre painting.

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397. S. R. Gifford, New York, N. Y., U. S.

OIL PAINTINGS.

Report.—Commended for eminence in landscape painting, as displayed in the following pictures: "Pallanza, Lago Maggiore;" "Fishing-Boats of the Adriatic;" "Lake Geneva;" "The Golden Horn;" "San Giorgio, Venice;" "Tivoli;" "Sunrise on the Sea-Shore."

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398. R. Swain Gifford, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "Mosque of Mohammed Ali, Cairo."

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399. F. A. Bridgman, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence—genre: "Flower of the Harem;" "Nubian Story-Teller."

400. G. Brüerke, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for excellence in genre painting of the historical class, as shown in his picture entitled "Columbus Discovering America."

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401. Francis B. Mayer, Annapolis, Md., U. S.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his "Attic Philosopher" and "Continentals."

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402. A. J. H. Way, Baltimore, Md., U. S.

OIL PAINTING.

Report.—Commended for remarkable excellence in still-life painting, "Grapes" (two panels).

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403. Charles Volkmar, Baltimore, Md., U. S.

OIL PAINTING.

Report.—Commended for great merit in landscape painting, "The Passing Shower, near Vichy, France."

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404. Edward Moran, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "Minot Ledge Light."

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405. H. H. Moore, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for excellence in genre painting.

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406. Jervis McEntee, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape: "The Woods of Ashokan;" "November;" "October Afternoon."

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407. W. A. Shade, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Tantalizing."

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408. D. Huntington, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for eminence in historical painting, "Titian and Charles V."

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409. E. M. Bannister, Providence, R. I., U. S.

OIL PAINTING.

Report.—Commended for merit in landscape painting, "Under the Oaks."

410. **J. B. Irving, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for excellence in genre painting, "The End of the Game."

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411. **David Johnson, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "Scenery on the Housatonic."

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412. **F. E. Church, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for eminence in landscape painting, "Chimborazo."

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413. **H. Peters Gray, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for eminence in genre painting, "The Apple of Discord."

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414. **M. F. H. De Haas, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Drifted Ashore."

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415. **Eastman Johnson, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for artistic excellence in genre: "What the Sea Says;" "The Prisoner of State;" "Old Stage-Coach."

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416. **H. Herzog, Philadelphia, Pa., U. S.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "Sentinel Rock, Yosemite."

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417. **P. F. Wharton, Philadelphia, Pa., U. S.**

OIL PAINTING.

Report.—Commended for merit in genre painting, "Perdita."

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418. **James H. Beard, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for excellence in genre painting, "The Attorney and his Clients."

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419. **P. F. Rothermel, Philadelphia, Pa., U. S.**

OIL PAINTING.

Report.—Commended for excellence in historical painting: "The Battle of Gettysburg;" and "The Defence of Sir Harry Vane."

420. W. T. Richards, Philadelphia, Pa., U. S.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "The Wissahickon."

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421. W. M. Hunt, Boston, Mass., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "Portrait."

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422. Jas. M. Hart, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "A Summer Memory of Berkshire."

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423. Miss Anna M. Lea, Philadelphia, Pa., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait: "Portrait;" "Genevieve de Brabant."

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424. Peter Moran, Philadelphia, Pa., U. S.

OIL PAINTING.

Report.—Commended for merit in genre painting, "Return of the Herd."

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425. J. R. Key, Boston, Mass., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "The Golden Gate—San Francisco."

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426. Thomas Hill, San Francisco, Cal., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Yosemite Valley."

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427. Thomas Moran, Newark, N. J., U. S.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "The Mountain of the Holy Cross."

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428. W. Whittredge, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape: "Twilight on the Shawangunk;" "Rocky Mountains from the Platte River."

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429. L. G. Pott, London, England.

OIL PAINTING.

Report.—Commended for great merit in genre painting, historical class, "Charles the First Leaving Westminster Hall after his Trial."

430. P. F. Poole, London, England.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "The Lion in the Path."

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431. Miss M. D. Mutrie, London, England.

OIL PAINTING.

Report.—Commended for great merit in genre painting.

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432. Miss A. F. Mutrie, London, England.

OIL PAINTING.

Report.—Commended for great merit in genre painting.

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433. George D. Leslie, London, England.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "The Arbor."

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434. Alfred Elmore, London, England.

OIL PAINTING.

Report.—Commended for excellence in genre painting.

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435. L. Alma Tadema, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence in historical painting: "The Vintage Festival;" "The Mummy."

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436. Frank Holl, London, England.

OIL PAINTINGS.

Report.—Commended for artistic excellence—genre: "The Lord gave, the Lord hath taken away; blessed be the name of the Lord;" "I am the resurrection and the life."

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437. Marcus Stone, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence—genre, "My Lady is a Widow and Childless."

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438. Chas. Edw. Perugini, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "Portrait of Mrs. C. E. Perugini."

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439. J. Clark, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence—genre, "The Sick Child.

440. Heywood Hardy, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence—animals, "The Disputed Toll."

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441. S. Luke Fildes, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence—genre, "Betty."

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442. Peter Graham, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Wind."

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443. Colin Hunter, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Trawlers Waiting for the Darkness."

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444. Vicat Cole, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Noon."

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445. Thomas Faed, Essex, England.

OIL PAINTING.

Report.—Commended for artistic excellence—genre, "Baith Faither and Mither."

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446. Sir Francis Grant, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "The Late Viscount Hardinge, Governor-General of India, Returning from the Battle of Ferozeshah."

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447. Frederick Leighton, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence in historical and poetical painting: "Summer Moon;" "Interior of a Jew's House, Damascus."

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448. George H. Boughton, London, England.

OIL PAINTING.

Report.—Commended for artistic excellence—genre, "God Speed."

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449. Wm. Powell Frith, London, England.

OIL PAINTING.

Report.—Commended for excellence in genre painting and portraiture: "The Marriage of H. R. H. the Prince of Wales in St. George's Chapel, Windsor, March 10, 1863,"—lent by Her Majesty the Queen; "The Railway Station;" "Pamela."

450. B. Riviere, London, England.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his pictures "Circe and the Companions of Ulysses," and "War Time."

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451. W. Q. Orchardson, London, England.

OIL PAINTING.

Report.—Commended for great excellence in landscape painting, "Moonlight on the Lagoons, Venice," and picture entitled "Prince Henry, Poins, and Falstaff."

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452. F. Jooravlef, St. Petersburg, Russia.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "The Dinner after the Funeral."

---

453. Alexander Gerimsky, Warsaw, Russia.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Game of Morra."

---

454. B. Lindholm, St. Petersburg, Russia.

OIL PAINTING.

Report.—Commended for artistic excellence in marine, "A Steamer in Floating Ice."

---

455. Henry Semiradsky, Russia.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "The Amulet-Seller."

---

456. Alexis Korzookhin, St. Petersburg, Russia.

OIL PAINTING.

Report.—Commended for merit as a genre painter, as shown in his picture entitled "Sunday Tea-Party."

---

457. John Aivazovsky, Theodosia, Crimea, Russia.

OIL PAINTING.

Report.—Commended for great merit as a marine painter, as shown in his picture entitled "Storm on the Black Sea, near the Crimean Coast."

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458. Albert Bierstadt, New York, N. Y., U. S.

OIL PAINTING.

Report.—Commended for eminence in landscape painting.

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459. Camille Alfred Pabst, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Alsatian Bride."

460. E. C. Dameron, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "The Pyramids."

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461. Evariste Vital Luminais, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Savages and Cattle."

---

462. Louis Priou, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "School for Young Satyrs."

---

463. Carolus Duran, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "Portrait of M'lle Croizette."

---

464. Edmond Charles Yon, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "The River Seine, near Marolles."

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465. Pierre Charles Comte, Paris, France.

OIL PAINTINGS.

Report.—Commended for artistic excellence—genre: "Training Rat Dogs;" "The King's Entertainment."

---

466. Léon Perrault, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "The Bather."

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467. Henri Harpignies, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Landscape near Renard."

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468. A. F. Schenck, Paris, France.

OIL PAINTINGS.

Report.—Commended for artistic excellence in animal painting: "Sheep in a Snow-Storm;" "Sheep on the Heath."

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469. Jean Henri Luber, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Forest in Normandy."

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470. Edouard Alexandre Sain, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence—genre, "Family Scene in the Pyrenees."

471. Georges Becker, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in historical painting, "Rizpah Protecting the Bodies of her Sons from Birds of Prey."

472. Karl Pierre Daubigny, Paris, France.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Valley of Pourville, Normandy."

473. Alexis Bogoliooboff (of Russia), Paris, France.

OIL PAINTING.

Report.—Commended for excellence as a landscape painter, as shown in his picture entitled "Ice-Drift on the Neva."

474. P. A. Brunet-Houard, Fontainebleau, France.

OIL PAINTING.

Report.—Commended for great excellence in genre painting, "Interior of a Menagerie."

475. A. Rosier, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "Morning on the Lagoons of Venice."

476. Henri Coroenne, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "Salutation."

477. A. R. Veron, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "On the Banks of the River Seine."

478. F. Zuber-Buhler, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "The Dew."

479. E. Gustave Conder, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "Alone in the House."

480. P. de Coninck, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting.

481. P. A. de Curzon, Paris, France.

OIL PAINTING.

Report.—Commended for great merit in genre painting, "The Serenade."

482. L. Victor Dupré, Paris, France.

OIL PAINTING.

Report.—Commended for merit in genre painting, "Watering Cattle."

483. Albert Maignan, Paris, France.

OIL PAINTING.

Report.—Commended for great merit in genre painting, "Helene at the Fountain."

484. A. E. Plassan, Passy, France.

OIL PAINTING.

Report.—Commended for merit in genre painting, "In Front of the Looking-Glass."

485. Ch. Landelle, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "A Fellah Woman."

486. E. Jadin, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "Sheikh Salah Dead in his Tent."

487. F. Edouard Zier, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "Julia."

488. Gustave Jundt, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "The Hair-Fair in Auvergne."

489. A. L. Jacomin, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in genre painting, "Bilboquet and his Companion."

490. René Princeteau, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in historical painting, "Portrait of Washington."

491. Emile Breton, Paris, France.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "The Canal of Courrières."

492. **Joseph Castiglione, Paris, France.**

OIL PAINTINGS.

Report.—Commended for artistic excellence in genre: "Visiting the Uncle Cardinal;" "The Warrants—Haddon Hall Castle."

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493. **Léon Comerre, Paris, France.**

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Cassandra."

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494. **Miss E. J. Gardner (of United States), Paris, France.**

OIL PAINTING.

Report.—Commended for excellence in genre painting, "Corinne."

---

495. **Clementina Tompkins (of United States), Paris, France.**

OIL PAINTING.

Report.—Commended for merit in genre painting, "An Artistic Debut."

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496. **A. Cassagne, Paris, France.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting, "Sully's Walk at Fontainebleau."

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497. **Edmond de Pratere, Brussels, Belgium.**

OIL PAINTING.

Report.—Commended for excellence in animal painting, as shown in his picture entitled "Stop."

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498. **Joseph Stallaert, Brussels, Belgium.**

OIL PAINTING.

Report.—Commended for excellence as a genre painter, as shown in his large picture entitled "The Cellar of Diomede: Scene at the Destruction of Pompeii."

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499. **A. Bouvier, Brussels, Belgium.**

OIL PAINTING.

Report.—Commended for excellence as a painter of landscape and marine, as shown in his picture entitled "Sunrise, Coast of Flanders."

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500. **Emile Keymeulen, Brussels, Belgium.**

OIL PAINTING.

Report.—Commended for excellence as a landscape painter, as shown in his picture entitled "After the Hurricane."

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501. **Paul Joseph Constantine Gabriel, Brussels, Belgium.**

OIL PAINTING.

Report.—Commended for excellence as a landscape painter, as shown in his picture entitled "Landscape—Morning View in Netherlands."

502. Theodore Gerard, Brussels, Belgium.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as displayed in his pictures entitled "The Birthday," and "An Unwelcome Guest."

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503. François Musin, Brussels, Belgium.

OIL PAINTING.

Report.—Commended for excellence as a landscape and marine artist, as displayed in his picture entitled "Sea-Shore at Scheveningen."

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504. Edmond de Schampheleer, Brussels, Belgium.

OIL PAINTING.

Report.—Commended for excellence as a landscape painter, as displayed in his painting entitled "Nymwegen, on the River Wahal, Netherlands."

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505. Jacques Rosseels, Antwerp, Belgium.

OIL PAINTING.

Report.—Commended for merit as a painter of landscape, as shown in his picture entitled "Mill on the River Scheldt."

---

506. Victor Lagye, Antwerp, Belgium.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his painting entitled "The Sculptor—Close of the Fifteenth Century."

---

507. Franz Vinck, Antwerp, Belgium.

OIL PAINTING.

Report.—Commended for distinguished merit as a genre painter of the historical class, as shown in his painting entitled "The Confederates in the Presence of Marguerite of Parma."

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508. Jean Verhas, Brussels, Belgium.

OIL PAINTING.

Report.—Commended for excellence as a landscape and marine painter, as shown in his picture entitled "Sea-Shore at Blankenberghe."

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509. Isidor Verheyden, Brussels, Belgium.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, as shown in his picture entitled "Landscape."

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510. G. J. A. Van Luppen, Antwerp, Belgium.

OIL PAINTINGS.

Report.—Commended for artistic excellence in landscape: "After the Rain;" "Before the Storm."

511. **N. de Keyser, Antwerp, Belgium.**

OIL PAINTING.

Report.—Commended for artistic excellence—genre, "Dante and the Young Girls of Florence."

512. **Joaquin Agrassot, Madrid, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "The Two Friends."

513. **Carlos H es, Madrid, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Reminiscences of the Pyrenees."

514. **Lorenzo Valles, Madrid, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence in historical painting, "Insanity of Donna Juana de Castilla."

515. **Benito Mercadé, Madrid, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence in historical painting, "Translation of St. Francis of Assisi."

516. **Alejo Vera, Madrid, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence in historical painting, "Burial of San Lorenzo at Rome."

517. **Cayetano Benavent, Barcelona, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence—marine, "Moonlight on the Sea.'

518. **Juan Rabada y Valvé, Barcelona, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence, "Landscape."

519. **Modesto Urgell, Barcelona, Spain.**

OIL PAINTING.

Report.—Commended for artistic excellence in landscape.

520. **Mrs. Henriette Ronner-Knip (of the Netherlands), Brussels, Belgium.**

OIL PAINTING.

Report.—Commended for eminence in genre painting entitled "Hare in his Covert."

521. Francisco Jover, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence in genre.

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522. Manuel Cabral y Vejarano, Seville, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence in genre.

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523. Gabriel Maureta, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence—historical subject, "Torquato Tasso Retiring to the Monastery of San Onofre."

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524. Francisco Domingo, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "A Duel in the Seventeenth Century."

---

525. Enrique Mélida, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Hall in Godoy's Palace."

---

526. Ricardo Navarrete, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Choir of Capuchin Monks."

---

527. Manuel Castellano, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence—historical subject.

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528. Gonzalo Alvarez y Espino, Seville, Spain.

OIL PAINTING.

Report.—Commended for distinguished merit as a painter of genre pictures, as shown in his "Annual Fair attended only by Men."

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529. Pablo Gonsalvo Perez, Madrid, Spain.

OIL PAINTING.

Report.—Commended for great merit as an artist, as shown in his picture entitled "The House of La Infanta at Saragossa."

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530. Antonio Muñoz, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence in genre.

531. José Casado, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence—historical subject.

532. Divicoro Puebla, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence—historical subjects.

533. Dionisio Fierros, Madrid, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence—genre.

534. Antonio Gisbert, Valencia, Spain.

OIL PAINTING.

Report.—Commended for artistic excellence in historical painting, "Landing of the Puritans in America."

535. José Maria Velasco, City of Mexico, Mexico.

OIL PAINTING.

Report.—Commended for merit as a landscape painter, as displayed in his picture en titled "The Valley of Mexico."

536. J. Gonzales, City of Mexico, Mexico.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "Evil Presentiments."

537. Victor Meireles de Lima, Rio de Janeiro, Brazil.

OIL PAINTING.

Report.—Commended for excellence in genre painting of the historical class, as shown in his large picture entitled "The First Mass in Brazil."

538. C. F. Sörensen, Copenhagen, Denmark.

OIL PAINTING.

Report.—Commended for artistic excellence in marine painting, as shown in his painting entitled "Sunset on the Atlantic—an Old Frigate in a Gale."

539. Achille Vertunni, Rome, Italy.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, as shown in his two pictures, viz., "The Ruins of Pæstum, Italy," "The Pyramids of Egypt."

540. Salvatore Marchesi, Parma, Italy.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Interior of the Choir of the Cathedral of Parma."

541. C. Maccari, Rome, Italy.

OIL PAINTINGS.

Report.—Commended for artistic excellence in genre: "Fond Memories;" "Music Hath Charms."

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542. Michele Cammarano, Rome, Italy.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "A Grandmother's Admonition."

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543. Anatolio Scifoni, Rome, Italy.

OIL PAINTINGS.

Report.—Commended for excellence in genre painting, as shown in his paintings "Preparation for a Feast in Pompeii," and "Offerings to the Lares."

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544. Roberto Fontana, Milan, Italy.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Evocation of Souls, from Robert le Diable."

---

545. Rafaello Faccioli, Bologna, Italy.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture called "Two o'Clock at the Procurator's Office in Venice."

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546. Achille Formis, Milan, Italy.

OIL PAINTING.

Report.—Commended for merit as a genre painter, as shown in his picture entitled "The Alpine Tourists."

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547. Annibale Cassioli, Florence, Italy.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his "Studio of Leonardo da Vinci."

---

548. Giuseppe Monticelli, Florence, Italy.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "A Revolt."

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549. Cav. Prof. Giovanni Fattori, Florence, Italy.

OIL PAINTING.

Report.—Commended for excellence as a painter of animals, as shown in his picture "The Horse-Market."

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550. Enrico Bartesago, Milan, Italy.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, as shown in his picture called "Noon in the Country."

551. A. Wagner, Munich, Germany.

OIL PAINTING.

Report.—Commended for artistic excellence.

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552. A. Achenbach, Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Storm at Vlissingen, Holland."

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553. Richard von Poschinger, Munich, Germany.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Environs of Munich."

---

554. Prof. Carl Steffeck, Berlin, Germany.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "The Crown Prince of Germany on the Battle-Fields of Worth and Weissenburg."

---

555. Carl Seibels, Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended for artistic excellence—animals, "Cattle."

---

556. Prof. Carl Lasch, Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "The Orphans."

---

557. Friedrich Hiddemann, Dusseldorf, Germany.

OIL PAINTINGS.

Report.—Commended for artistic excellence—genre: "Practice Makes Perfect;" "In the Park."

---

558. Gustav Richter, Berlin, Germany.

OIL PAINTING.

Report.—Commended for artistic excellence—portrait, "Hon. George Bancroft."

---

559. Ernst Meissner, Munich, Germany.

OIL PAINTING..

Report.—Commended for artistic excellence in animal painting, "Young Ones."

---

560. Walter Shirlaw (of United States), Munich, Germany.

OIL PAINTINGS.

Report.—Commended for excellence in genre painting, "Toning the Bell," and "Feeding Poultry."

561. W. M. Chase (of United States), Munich, Germany.

OIL PAINTING.

Report.—Commended for great merit in genre painting, "'Keying up'—The Court Jester."

---

562. Meyer von Bremen, Berlin, Germany.

OIL PAINTING.

Report.—Commended for distinguished merit in genre painting, as shown in his picture entitled "The Gossips."

---

563. Albert Schwartz, Berlin, Germany.

OIL PAINTING.

Report.—Commended for distinguished merit as an artist in oil painting, as displayed in his picture entitled "Broken Flowers."

---

564. George F. Folingsby, Munich, Germany.

OIL PAINTING.

Report.—Commended for excellence in genre painting of the historical class, as displayed in his picture entitled "Lady Jane Grey's Triumph over Bishop Gardiner."

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565. Hermann Behmer, Weimar, Germany.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "Girl with Wild Roses."

---

566. Rudolf Jordan, Munich, Germany.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "Happy Old Age."

---

567. W. Xylander, Schleissheim, Germany.

OIL PAINTING.

Report.—Commended for distinguished merit as a landscape painter, as displayed in his picture entitled "Mouth of the Thames."

---

568. Carl Jungheim, Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended for excellence in landscape painting, as shown in his painting of the "Lake of the Four Cantons."

---

569. Ernst Bosch, Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as displayed in his picture entitled "The Old Shepherd and his Granddaughter."

570. Prof. Ferdinand Schaus, Weimar, Germany.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "A Dryad."

---

571. E. Crofts (of Great Britain), Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended for merit in genre painting, "Ligny."

---

572. G. Gräf, Berlin, Germany.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "Penserosa."

---

573. E. Koerner, Berlin, Germany.

OIL PAINTING.

Report.—Commended for distinguished excellence in landscape painting, as displayed eminently in his picture entitled "Mahmudi Canal near Alexandria."

---

574. J. Bosboom, The Hague, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Church at Treves."

---

575. Hans Makart, Vienna, Austria.

OIL PAINTING.

Report.—Commended for artistic excellence in historical painting, "Venice Paying Homage to Caterina Cornaro."

---

576. Gustav Kuntz, Vienna, Austria.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "The Nun's Reverie."

---

577. Louisa von Parmentier, Vienna, Austria.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Landscape near Munich."

---

578. Henry von Angeli, Vienna, Austria.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "Portraits."

---

579. Karl Probst, Vienna, Austria.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "Portrait Study."

580. Francis Leo Ruben, Vienna, Austria.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "Venetian Society."

---

581. Charles Riedel, Vienna, Austria.

OIL PAINTING.

Report.—Commended for merit in genre painting in his picture entitled "An After-Dinner Nap."

---

582. Minna Hoegel, Vienna, Austria.

OIL PAINTING.

Report.—Commended for excellence in still-life painting, as displayed in the painting entitled "Still-Life—Game."

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583. Louis Minigerode, Vienna, Austria.

OIL PAINTING.

Report.—Commended for excellence in figure-painting in oil, as displayed in his picture entitled "Sleeping Nymph."

---

584. Hans Canon, Vienna, Austria.

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "The Page."

---

585. Andreas Grabowski, Lemberg, Austria.

OIL PAINTING.

Report.—Commended for artistic excellence in portrait, "Portrait."

---

586. Eugene Felix, Vienna, Austria.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Pan and Bacchantes."

---

587. Johannes Martin Grimelund, Norway.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "A Summer Morning in the Birch Forest."

---

588. Hans Gude, Norway.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape: "A Fresh Breeze, Norwegian Coast;" "Calm, Christianiafiord."

---

589. Otto Sinding, Norway.

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Ruth and Boaz."

590. **H. D. Kruseman van Elten, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Holland Landscape."

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591. **W. C. Nakken, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Hay-Making—Normandy."

---

592. **Herman F. C. ten Kate, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for artistic excellence in genre: "The Fortunes of War, Seventeenth Century;" "Gamblers, Seventeenth Century."

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593. **C. Bisschop, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for artistic excellence in genre: "Dieuwke;" "At Church."

---

594. **H. A. van Trigt, Hilversum, Netherlands.**

OIL PAINTING.

Report.—Commended for artistic excellence in genre, "Norwegian Women Bringing Children to be Baptized."

---

595. **A. Mauve, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, "Hauling up the Fishing-Boat."

---

596. **Miss Maria Vos, Oosterbeek, Netherlands.**

OIL PAINTING.

Report.—Commended for artistic excellence in still-life painting, "Still Life."

---

597. **W. J. Martens, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Vestibule of St. Mark's in Venice."

---

598. **J. A. Rust, Amsterdam, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "View of Amsterdam, Sixteenth Century."

---

599. **L. Apol, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Early Morning."

600. J. H. Scholten, Haarlem, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Sunday Morning."

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601. Ch. Rochussen, Rotterdam, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Cheese-Market in North Holland."

---

602. C. Cunaeus, Amsterdam, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "In Winter."

---

603. I. Israels, The Hague, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "After the Storm."

---

604. J. W. van Borselen, The Hague, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "A Holland Landscape."

---

605. J. J. van der Maaten, Apeldoorn, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "The Canal of Apeldoorn."

---

606. S. L. Verveer, The Hague, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Village of Scheveningen."

---

607. C. Springer, Amsterdam, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "View of Toren Street in Enkhuyzen."

---

608. Elchanon Verveer, The Hague, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in genre painting entitled "The Widow."

---

609. H. W. Mesdag, The Hague, Netherlands.

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "Evening on the Beach."

610a. **J. C. Grieve, Jr., Amsterdam, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "The River Y near Amsterdam."

611. **W. Roelofs (of The Hague, Netherlands), Brussels, Belgium.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "A Thunder-Storm."

612. **J. van de Sande Backhuijzen, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting entitled "River Landscape."

613. **M. Bocks, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting.

614. **J. F. van Deventer, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting, as shown in his picture entitled "Holland Landscape."

615. **J. Mari H. ten Kate, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in painting, as shown in his picture entitled "Good Friends."

616. **J. A. B. Stroebel, The Hague, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in genre painting, as shown in his picture entitled "The Deacons of the Silversmiths' Guild conferring a Freeman's Certificate."

617. **J. W. Bilders, Amsterdam, Netherlands.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting: "Landscape near Vorden;" "Landscape."

SIGNING JUDGES OF GROUP XXVII.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

ANTONIO TANTARDINI, 1, 30, 57, 82, 86, 144, 146, 154, 155, 156, 161, 162, 172, 173, 175, 176, 179, 180, 183, 186, 220, 221, 389.

DONALD G. MITCHELL, 2, 4, 7, 8, 9, 11, 12, 15, 21, 24, 25, 26, 27, 37, 39, 46, 56, 61, 67, 68, 70, 71, 72, 73, 87, 88, 93, 95, 96, 97, 98, 107, 109, 110, 129, 133, 134, 135, 136, 137, 139, 140, 142, 143.

JAMES L. CLAGHORN, 3, 517, 523, 524, 525, 526, 538.

FRITZ L. VON DARDEL, 5, 29, 47, 169, 188, 189, 202, 203, 204, 216, 217, 222, 223, 228, 230, 344, 365.

F. HILL SMITH, 6, 19, 22, 23, 41, 42, 64, 81, 148, 149, 150, 151, 153, 163, 164, 167, 198, 199, 200, 201, 205, 206, 211, 214, 215, 218, 219, 225, 226, 227, 234, 235, 236, 237, 238, 240, 242, 244, 246, 247, 248, 265, 266, 267, 268, 270, 271, 272, 273, 275, 276, 277, 278, 282, 384, 385, 386, 387, 388, 421, 438, 440, 462, 465, 467, 471, 472, 493, 555, 556, 577.

P. N. ARBO, 10, 13, 44, 65, 66, 74, 84, 152, 157, 160, 168, 177, 178, 181, 182, 207, 229, 269.

HENRY DRAPER, 14, 252, 254, 255, 256, 257, 258, 264, 283, 284, 285, 287, 289, 290, 291, 292, 293, 294, 297, 298, 299, 300, 302, 303, 304, 306. 307, 308, 311, 312, 313, 314, 315, 317, 318, 320, 321, 322, 325, 327, 329, 334, 335, 336, 337, 340, 348, 352, 354, 356, 357, 359, 360, 363, 366, 367, 368, 369, 371, 372, 373, 374, 378, 379.

PETER GRAHAM, 16, 17, 20, 31, 33, 34, 35, 36, 38, 40, 43, 45, 48, 59, 62, 63, 69, 94, 102, 103, 104, 105, 112, 117, 120, 121, 138, 141.

J. E. SAINTIN, 18, 50, 51, 52, 53, 54, 55, 60, 75, 78, 80, 83, 281, 399, 425, 453, 464, 534, 542, 557, 595.

C. SCHLESINGER, 28, 187, 190, 191, 195, 196, 210, 261, 274, 390, 392, 394, 415, 435, 439, 468, 470, 513, 553, 554, 558, 586.

CARL COSTENOBLE, 32, 49, 58, 76, 79, 85, 145, 159, 165, 170, 171.

GEO. WARD NICHOLS, 77, 147, 158, 166, 174, 184, 185, 351, 383, 426, 461, 469, 511, 515, 541, 544, 551, 575, 587, 588.

JENS V. DAHLERUP, 89, 90, 91, 92, 99, 100, 101, 106, 108, 111, 113, 114, 115, 116, 118, 119, 122, 123, 124, 125, 126, 127, 128, 130, 131, 132.

CHARLES WEST COPE, 192, 193, 194, 197, 209, 212, 213, 231, 232, 233, 239, 241, 243, 245, 262, 279, 280, 428, 441, 442, 444, 446, 576, 578, 591.

H. D. KRUSEMAN VAN ELTEN, 208, 406, 414, 512, 589, 592, 593, 594, 596.

GUGLIELMO DE SANCTIS, 224, 422, 436, 437, 447, 460, 463, 466.

H. VOGEL, 249, 250, 251, 253, 259, 260, 263, 286, 288, 295, 296, 301, 305, 309, 310, 316, 319, 323, 324, 326, 328, 330, 331, 332, 333, 338, 339, 341, 342, 343, 345, 346, 347, 349, 350, 353, 355, 358, 361, 362, 364, 370, 375, 376, 377, 380, 381, 382.

E. VAN HEEMSKERCK VAN BEEST, 391, 393, 395, 396, 397, 398, 400, 401, 402, 403,

404, 405, 408, 409, 410, 411, 412, 413, 416, 417, 418, 419, 420, 424, 427, 455, 456, 457, 473, 494, 495, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 528, 529, 535, 536, 537, 543, 545, 546, 547, 548, 549, 550, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 572, 573, 580, 581, 582, 583, 584.

El C. del Donadio, 407, 423, 492, 510, 514, 516, 518, 519, 521, 522, 527, 530, 531, 532, 533, 540, 552, 559, 585.

Brantz Mayer, 429, 430, 431, 432, 433, 434, 449, 450, 451, 452, 453, 454, 458, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 496, 520, 539, 571, 574, 590, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617.

John F. Weir, 443, 445, 448, 579.

SUPPLEMENT TO GROUP XXVII.

REPORTS

OF

JUDGES ON APPEALS.

JUDGES.

JOHN FRITZ, Bethlehem, Pa.
EDWARD CONLEY, Cincinnati, Ohio.
CHARLES STAPLES, JR., Portland, Me.
BENJ. F. BRITTON, New York City.
H. H. SMITH, Philadelphia, Pa.
COLEMAN SELLERS, Philadelphia, Pa.
JAMES L. CLAGHORN, Philadelphia, Pa.
HENRY K. OLIVER, Salem, Mass.
M. WILKINS, Harrisburg, Oregon.
S. F. BAIRD, Washington, D. C.

1. E. G. Chormann, Philadelphia, Pa., U. S.

ARTIST'S EASEL.

Report.—His portable easel, color-box, seat, etc., combined.

Commended for ingenuity and adaptation to its intended use, viz., to furnish an artist with a complete portable outfit, which, when closed, occupies but little space.

2. W. Curtis Taylor, Philadelphia, Pa., U. S.

PHOTOGRAPHS.

Report.—His composition pictures or "genre" photographs are superior, carefully and artistically arranged, and well executed. Portraits of eminent men excellent.

3. Van Gunden, Young, & Drumm, Philadelphia, Pa., U. S.

TOMBSTONES AND MURAL MARK WORK.

Report.—Commended for good workmanship and design.

4. Alexander & Joseph Kova, Beyrout, Syria.

PHOTOGRAPHS OF ARABIC COSTUMES OF SYRIA.

Report.—An exceedingly interesting collection of photographs showing the costumes and characteristics of the Arabs. Commended for excellence.

5. Nicholas Svertchkof, Tzarskoe-Selo, near St. Petersburg, Russia.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, as shown in his painting entitled "Carnival Week in the Country."

6. P. D. Richards, West Medford, Mass., U. S.

WOOD CARVINGS.

Report.—Commended for good design and workmanship on frame for picture and box.

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7. D. W. Butterfield, Boston, Mass., U. S.

LARGE LANDSCAPE VIEWS.

Report.—Large views of White Mountain scenery. Commended for superior execution and fine atmospheric effect.

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8. Allen & Rowell, Boston, Mass., U. S.

ENLARGED PHOTOGRAPHS IN PERMANENT PIGMENTS.

Report.—Commended for enlarged carbon prints, fine in tone and excellent as photographs.

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9. F. Gutekunst, Philadelphia, Pa., U. S.

PHOTOGRAPHS.

Report.—Plain photographs from untouched negatives of large size are superior in execution and finish, as also in artistic pose. The entire exhibit of finished and untouched work shows a very high grade in the art. In landscape photography, pictures clear in detail, excellent in execution. Portraits glace superb in execution and artistic pose.

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10. Carl Guthers, St. Louis, Mo., U. S.

OIL PAINTING.

Report.—Meritorious in the poetic, as shown in painting entitled "Awakening Spring."

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11. J. Foxcroft Cole, Boston, Mass., U. S.

OIL PAINTING.

Report.—Meritorious in landscape and figure, as shown in painting called "Cows Ruminating."

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12. Marcus Ormsbee, Brooklyn, N. Y., U. S

PHOTOGRAPH WASHER.

Report.—Commended for utility and fitness for purpose intended.

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13. J. H. Folsom, Danbury, Conn., U. S.

CABINET AND SOLAR PRINTS.

Report.—Plain solar enlargements, full in tone and modeling. Cabinet pictures very good.

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14. Mrs. S. T. Darrah, Boston, Mass., U. S.

OIL PAINTING.

Report.—Commended as meritorious in landscape, as shown in her picture of "Lake Champlain."

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15. A. Hoen & Co., Baltimore, Md., U. S.

CHROMO-LITHOGRAPH AND LITHOCAUSTIC PROCESS.

Report.—Commended for excellence in chromo-lithographic art, as shown in picture "The Continentals."

In their lithocaustic process in connection with lithographic engravings, being a new application of etching on stone, invented and patented by them.

16. **G. H. Story, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Excellence in genre painting, as exemplified in his work entitled "The Young Student."

17. **Thomas Hicks, New York, N. Y., U. S.**

OIL PAINTINGS.

Report.—Commended for excellence in portraiture, as shown in his paintings of "General Meade" and "Dr. Delafield."

18. **Mrs. J. M. Miller, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended as meritorious in landscape, as shown in painting entitled "Old Mill at Springfield, L. I."

19. **L. W. Seavey, New York, N. Y., U. S.**

PHOTOGRAPHIC BACKGROUNDS, PAPIER MACHÉ, FURNITURE, AND ACCESSORIES.

Report.—Commended for well-drawn backgrounds, artistic furniture, and good photographs of his backgrounds and accessories.

20. **Augustus Haas, New York, N. Y., U. S.**

ELECTROTYPE REPRODUCTIONS OF MEDALS AND RELIEFS.

Report.—Commended for superiority of workmanship.

21. **J. F. Cropsey, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for beauty as a landscape painting, called "Old Bon Church, Isle of Wight."

22. **Schwind & Kreuger, New York, N. Y., U. S.**

PHOTOGRAPHIC PORTRAITS.

Report.—Portraits of children, especially in groups, showing great patience and a high standard of excellence as photographs.

23. **John La Farge, New York, N. Y., U. S.**

OIL PAINTING.

Report.—Commended for artistic merit in landscape, as shown in his painting called "Bishop Berkeley's Rock, New York."

24. **J. Ganz, Zurich, Switzerland.**

PHOTOGRAPHS.

Report.—Commended for good selection of subjects, and excellent photographic results.

25. **E. Bierstadt, New York, N. Y., U. S.**

PHOTOGRAPHS IN PRINTING INK BY ALBERT'S PROCESS.

Report.—Commended for great merit in the department of art applied; execution excellent; preservation of half-tone remarkable.

26. J. Foxcroft Cole, Boston, Mass., U. S.

OIL PAINTING.

Report.—Commended for artistic excellence in landscape, as shown in painting entitled "Coast Scene in Normandy."

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27. H. G. Bachman, Philadelphia, Pa., U. S.

IVORY CARVINGS.

Report.—Commended for artistic skill in workmanship and drawing.

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28. A. Askerold, Bergen, Norway.

OIL PAINTING.

Report.—Commended as meritorious in landscape, as shown by his work called "Summer Day at the Mountain Tarn."

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29. Frank M. Good, London, England.

VIEWS OF PALESTINE.

Report.—Good in every technical quality, and very artistic in selection of view and in lighting.

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30. The Typographic Etching Co., London, England.

ENGRAVINGS BY THE TYPOGRAPHIC PROCESS.

Report.—Their reproductions of existing originals shown in prints from relief plates, remarkably clear and perfect in detail.

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31. J. S. & A. B. Wyon, London, England.

MEDALS AND SEALS.

Report.—Commended for superiority of design and execution.

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32. Erskine Nicol, London, England.

OIL PAINTING.

Report.—Commended as meritorious in genre painting, as shown in his "Paying the Rent."

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33. Christian William Dashwood, London, England.

ORIGINAL DESIGNS FOR OIL CLOTH.

Report.—His three designs, one Egyptian, one Arabian, and the other representing inlaid stones, well drawn, effectively colored, and well adapted to reproduction by block printing.

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34. T. Sakai, Kiyoto, Japan.

PHOTOGRAPHS.

Report.—Commended for excellent landscapes and character photographs of Japan.

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35. Kikuchi Yosai, Tokio, Japan.

WATER-COLOR PAINTINGS.

Report.—Collection of paintings in album showing remarkable vigor, and, in the case of animals and birds, great power of expression.

36. Shibata Zeshin, Tokio, Japan.

LACQUER PAINTINGS.

Report.—Lacquer paintings on thin paper, curious and instructive; a remarkably truthful and vigorous delineation of natural objects.

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37. A. Sege, Paris, France.

OIL PAINTING.

Report.—Artistic excellence in landscape, as shown in his painting called "Fountain at Nantois."

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38. P. A. Protais, Paris, France.

OIL PAINTING.

Report.—Artistic merit in landscape and figure, as shown in his painting called "Soldiers at Halt."

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39. Jean Bernard Wittkamp, Antwerp, Belgium.

OIL PAINTING.

Report.—Meritorious in drawing figure and expressing the story, as shown in his picture of "Byron's Parisina."

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40. François Antoine Bossuet, Brussels, Belgium.

OIL PAINTING.

Report.—Commended as meritorious in landscape painting, as shown in picture entitled "Rome, View from the River Tiber."

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41. Jean Portaels, Brussels, Belgium.

OIL PAINTINGS.

Report.—Commended for excellence in genre or figures, as shown in his pictures entitled "Morning," and "Deception."

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42. David Col, Antwerp, Belgium.

OIL PAINTING.

Report.—Excellence in genre painting, as shown in his picture called "In the Wine-Cellar."

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43. National Mint, Madrid, Spain.

DIES AND COINS.

Report.—Dies and coins of the National Mint, showing good work in dies and coinage.

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44. J. Arnaldo Nogueira Mollarinho, Oporto, Portugal.

COPPER AND SILVER MEDALS.

Report.—Commended for very good workmanship and design.

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45. Michis Cattaneo Maria, Milan, Italy.

OIL PAINTING.

Report.—Commended for excellence in still life, as shown in painting called "Flowers."

46. P. F. Connelly (of United States), Florence, Italy.

STATUARY IN BRONZE AND MARBLE.

Report.—Artistic merit in sculpture, as shown in his bronze group, "Honor Arresting the Triumph of Death;" and in marble, "Thetis Thinking how she may regain the Birthright of her Son Achilles."

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47. Prof. Emanuel Caroni, Florence, Italy.

SCULPTURE.

Report.—Commended as meritorious in sculpture for pose and other good qualities needed in such works, as shown in works entitled "Youth and Butterfly;" "L'Africana."

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48. A. Tidemand (of Norway), Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended for excellence in landscape and figure, as shown in his painting called "Peasants in a Wood."

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49. Otto Sinding (of Norway), Munich, Germany.

OIL PAINTING.

Report.—Commended as meritorious in genre, as shown in his painting entitled "Fight at a Christmas Feast."

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50. "Germania" Chromo-Lithographic Co., Berlin, Germany.

CHROMO-LITHOGRAPHIC PICTURES.

Report.—Very cheap pictures; well printed; register good.

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51. S. Jacobsen (of Norway), Dusseldorf, Germany.

OIL PAINTING.

Report.—Excellence in landscape, as shown in his painting of "Birch Forest."

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52. Otto Seitz, Munich, Bavaria, Germany.

OIL PAINTING.

Report.—Commended as meritorious in the poetic line, as shown in his picture called "Neptune's Bridal."

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53. August Jernberg (of Sweden), Dusseldorf, Germany.

OIL PAINTING.

Report.—Excellence in still life, as shown in picture, "Preparation for Meal."

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54. B. Nordenberg (of Sweden), Dusseldorf, Germany.

OIL PAINTING.

Report.—Commended as meritorious in genre, as shown in his picture entitled "Wedding in a Swedish Country Church."

55. **Baroness Amelie von Schwerin (of Sweden), Dusseldorf, Germany.**

OIL PAINTING.

Report.—Excellence in landscape and cattle, as shown in painting entitled "Landscape with Cattle."

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56. **P. Sebah, Constantinople, Turkey.**

PHOTOGRAPHIC VIEWS OF ATHENS, AND INTERIOR OF ST. SOPHIA.

Report.—Commended for very superior photographic excellence, both in the selection of views and in the production of the pictures.

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57. **Montani Effendi, Constantinople, Turkey.**

SERIES OF PLATES ILLUSTRATING OTTOMAN ARCHITECTURE.

Report.—They are carefully selected models and decorations, illustrating Ottoman architecture, accompanied by scientific descriptions illustrating the history of its art and architecture.

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58. **Miguel Lacroix, Buenos Ayres, Argentine Republic.**

MOSAIC WOOD WORK.

Report.—As shown in his exhibit, mosaic box and table.

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59. **Joaquim Molinari, Buenos Ayres, Argentine Republic.**

WOOD CARVING.

Report.—Commended for artistic merit in carving, as shown in arm-chair, carved flowers and birds.

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60. **F. Nunez, Buenos Ayres, Argentine Republic.**

MOSAIC WOOD WORK.

Report.—Commended as artistic meritorious wood mosaic.

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61. **Baron O. Hermelin, Stockholm, Sweden.**

OIL PAINTINGS.

Report.—Commended for artistic excellence in "marine," as shown in his works.

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62. **J. Ch. Boklund, Stockholm, Sweden.**

OIL PAINTING.

Report.—Commended for artistic merit, as shown in his painting called "Consultation."

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63. **Edward Bergh, Stockholm, Sweden.**

OIL PAINTINGS.

Report.—Commended for excellence in landscape, as shown in his pictures, "Birch Forest," and "Interior of Pine Forest."

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64. **A. Kallenberg, Stockholm, Sweden.**

OIL PAINTING.

Report.—Commended as meritorious in landscape, as shown in his painting called "Beech Forest."

65. **George Tinworth, London, England.**

TERRA-COTTA PANELS OF SCRIPTURAL SUBJECTS.

Report.—Commended for very artistic productions in terra-cotta of Scriptural subjects, showing artistic merit of high order.

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66. **A. Lindstrom (of Sweden), Munich, Germany.**

OIL PAINTING.

Report.—Commended for excellence in landscape painting, as shown by his work entitled "Autumn Landscape."

SIGNING JUDGES OF SUPPLEMENT TO GROUP XXVII.

The figures annexed to the names of the Judges indicate the reports written by them respectively.

COLEMAN SELLERS, 1, 2, 3, 4, 6, 7, 8, 9, 12, 13, 19, 20, 22, 24, 25, 29, 30, 31, 33, 34, 35, 36, 43, 50, 56, 65.

JAMES L. CLAGHORN, 5, 10, 11, 14, 15, 16, 17, 18, 21, 23, 26, 27, 28, 32, 37, 38, 39, 40, 41, 42, 45, 46, 47, 48, 49, 51, 52, 53, 54, 55, 57, 58, 59, 60, 61, 62, 63, 64, 66.

EDWARD CONLEY, 44.